DOCUMENT RESUME

ED 040 863 SE 008 871

TITLE Australian Science Education Project Guidelines Conference.

INSTITUTION Australian Ministry of Science and Education, Canberra.

PUB DATE 70

NOTE 242p.; Report of papers presented at the Australian Science Education Project Conference (Clayton, Victoria, Australia, January 18-23, 1970)

EDRS PRICE EDRS Price MF-$1.00 HC-$12.20

DESCRIPTORS *Curriculum Development, *Educational Objectives, Interdisciplinary Approach, International Education, *Science Education, *Secondary School Science, *Teacher Education

IDENTIFIERS Australian Science Education Project

ABSTRACT

Reported is a conference held to develop guidelines for the Australian Science Education Project (ASEP), a national project charged with producing curriculum materials for junior high school science. Included are copies of the addresses given and questions considered by discussion groups, and notes of the findings of the discussion groups. Questions considered include the general objectives of ASEP, the kinds of learning outcomes to be aimed at, the kinds of learning experiences and materials to be provided, questions of flexibility and sequencing, the use to be made of previously developed materials, the integration of the materials into the curricula of the different states, and plans for teacher education, evaluation, and research. (EB)

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# AUSTRALIAN SCIENCE EDUCATION PROJECT *

## GUIDELINES CONFERENCE

The ASEP Guidelines Conference was held at Farrer Hall, Monash University, Clayton, Victoria from Sunday 18 January to Friday 23 January 1970.

### General Rationale

At the Conference, a set of proposals regarding the possible directions such a project might take were presented by the executive officers of the Project. In presenting their proposals the Project executive followed the basic purposes of the Project as determined by the Committee of Management. Paralleling these proposals, a series of papers was given by persons outside the Project, so that an alternative perspective was presented along with the proposals. The Conference reacted to both sets of papers in syndicate sessions and following these, plenary sessions attempted to formulate a set of guidelines and recommendations to guide the executive in its future actions.

### The Purposes of the Conference

The purposes of the Conference were to

1. present proposals and feasible possibilities to meet the purposes stated for the Australian Science Education Project;
2. formulate guidelines and recommendations to help determine the direction of development and evaluation of a science education program for grades 7-10;
3. determine the roles of the states and state bodies in the Project.

### Matters Considered by the Conference

Five main topics were considered:

1. an overview of Australia's educational requirements - trends and issues;
2. aims and objectives of the Australian Science Education Project;
3. some possible alternatives for materials development and the outcomes expected;
4. possibilities and probabilities for evaluation of ASEP;
5. implications of a national project to the states and the nation.

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* For a summary of the Australian Science Education Project's history and present status, refer to Appendices A, C and D of Mr H.O. Howard's paper 'The Purposes of the Australian Science Education Project', presented to the ASEP Conference on Monday 19 January 1970.

# AUSTRALIAN SCIENCE EDUCATION PROJECT
# GUIDELINES CONFERENCE

## MONASH UNIVERSITY - JANUARY 1970

| PROGRAMME SUMMARY | CONFERENCE PAPERS |
|---|---|
| Sunday January 18 | |
| Official opening by Hon.N.Bowen QC, MP, Minister for Education and Science, followed by the first conference paper | Opening Address : Hon.N.Bowen QC, MP, Minister for Education and Science, introduced by Mr T.J.Ford<br>"Trends and Issues in Education in Australia" - Dr Wm.C. Radford, Director, ACER |
| Monday January 19 | |
| The broad aims of the Project and some implications from other curriculum development projects<br>morning : two papers and commentary<br>afternoon : syndicate discussions<br>evening : plenary session | "The Purposes of the Australian Science Education Project" - Mr H.O. Howard, Director, ASEP<br>"Implications from the curriculum development projects for curriculum development in Australia" - Professor P.J.Fensham, Professor of Science Education, Monash University<br>Commentary on preceding papers - Dr R.S. Vickery<br>Western Australian State Advisory Committee Position Paper<br>Syndicates - Questions for discussion (prepared by the Project)<br>- Questions for discussion (prepared by Conference Groups)<br>Syndicate Session Report |

Tuesday January 20

The kinds of materials to be developed by the Project considered against the wider perspectives of learning and teaching

morning : two papers
afternoon : syndicate discussions
evening : plenary session

"The kinds of materials to be developed ... probabilities and possibilities - Mr L.G.Dale, Assistant Director, ASEP

"Learning and instruction - the kinds of pupil outcomes to be expected from different kinds of learning experiences" - Dr M.L.Turner, Reader in Education, La Trobe University

Syndicates - Questions for discussion (prepared by the Project)
" " " (prepared by Conference Groups)
" " " (prepared by Dr Turner)

Syndicate Session Report

Plenary Session Report

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Wednesday January 21

The evaluation and service aspects of the Project

morning : two papers
afternoon : syndicate discussions
evening : plenary session

"The kinds of services and evaluative procedures that could be provided for in the Australian Science Education Project" - Dr G.A. Ramsey, Assistant Director, ASEP

"Evaluation - perspectives and possibilities" - Mr L.Blazely, Superintendent of Research, Tasmanian Education Department

Syndicates - Questions for discussion (prepared by the Project)
" " " (prepared by Conference Groups)

Syndicate Session Report

Plenary Session Report

Thursday January 22

The States and their relation to the Project

morning : comments from each State Advisory Committee
afternoon : syndicate discussion
evening : plenary session

"The States and the Australian Science Education Project"
- Members of State Advisory Committees:
    - Dr R.S.Vickery, Western Australia
    - Mr J.M.Mayfield, South Australia
    - Mr S.F.Eldridge, Tasmania
    - Mr D.W.Neale, Victoria
    - Mr H.K.Carey, New South Wales
    - Mr G.W.Robins, Queensland

"Implications to the Nation" - Mr B.Rechter, Chief Research Officer, ACER

Aims of ASEP - First Draft

Syndicates - Questions for discussion re the role of the States
Questions for discussion re the aims of ASEP

Syndicate Session Report re role of the States

Syndicate Session Report - Comments on Aims - First Draft

Plenary Session Report (Discussion of Rationale)

Comments and expressions of opinion circulated by Conference members but not formally discussed:
- Bennett Mr D.M. Turner Mr M.L. : A comment on some basic issues
- Johnson, Prof.B. : Objectives of the Web of Life
- Maclay, Mr R. : The aims of selection of science content for Grades 7-10
- Rechter, Mr B. : Comment
- Shepherd, Mr R. : Views on the Aims
- Wilson, Mr N. : Some suggested amendments to the Aims. Criteria for selection of social and psychological material for science learnings
- Wilkinson Mr R.H. : What are the criteria for selection of the science-linked experiences?

Friday January 23

Review of the Conference:

morning : special syndicate sessions to review
the four main areas : AIMS, MATERIALS,
SERVICES, THE ROLE OF THE STATES
afternoon : plenary session to consider, amend
where necessary and accept special
syndicate reports

: summing up by Mr M. Bishop
: final remarks by Dr Wm. C. Radford

Special Syndicate Session Reports:

Aims
Materials
Services
Role of the States

Plenary Session Report

Summary statements on AIMS, MATERIALS, SERVICES, ROLE OF THE STATES, to act as a possible basis for a future announcement about the Project

"Summing up" - Mr M. Bishop, Headmaster, Cranbrook School,
Sydney

Closing Remarks - Dr Wm.C. Radford, Director, ACER

# ASEP GUIDELINES CONFERENCE
## 18-23 JANUARY 1970
## PARTICIPANTS

| | | |
|---|---|---|
| Mr D.M.Bennett | Chief Research Officer | ACER |
| Mr K.Betjeman | Science Master | Bentley Senior High School, WA |
| Mr M.Bishop | Headmaster | Cranbrook School, Sydney |
| Mr L.Blazely | Superintendent of Research and Special Education | Education Department, Hobart |
| Mr H.K.Carey | Inspector of Schools | Education Department, Sydney |
| Miss Y.Carter | Science Mistress | Fort St GHS, Sydney |
| Mr R.Cowban | Curriculum Officer | Curriculum and Research Branch, Educ. Dept. Melbourne |
| Mr L.G.Dale | Assistant Director | ASEP |
| Mr J.M. Davis | Lecturer | Kelvin Grove Teachers' C.Brisbane |
| Mr S.F.Eldridge | Deputy Headmaster | Hobart Matriculation College |
| Prof.P.J.Fensham | Professor Science Education | Monash University |
| Mr T.J.Ford | Acting Assistant Director of Secondary Education | Education Department, Melbourne |
| Mr E.D.Gardiner | Chairman,Commonwealth Government Advis.Comm. on Standards for Sci. Facilities in Independent Schools | Melbourne |
| Mr H.O.Howard | Director | ASEP |
| Mr L.E.Howell | Area Specialist | ASEP |
| Mr B.M.Jarman | Area Specialist | ASEP |
| Prof.B.Johnson | Professor Zoology | University of Tas. |
| Dr W.A.F.Lang | Area Specialist | ASEP |
| Mr R.W.Maclay | Senior Lecturer | Sydney Teachers' Col. |
| Miss J.Maling | Senior Research Officer | ACER |
| Mr J.M.Mayfield | Inspector of Schools | Educ.Dept. Adelaide |
| Mr K.Moritz | Area Specialist | ASEP |
| Prof.J.D.Morrison | Professor Chemistry | La Trobe University |
| Mr R.Murfett | Education Officer | Aust. Broadcasting Commission,Melbourne |
| Mr D.W.Neale | Inspector of Second. Schools | Education Department, Melbourne |
| Mr R.Page | Science Master | Education Department, Adelaide |
| Mrs E.C.Palmer | Research Officer | ASEP |
| Bro.C.Pratt | Headmaster | Sacred Heart College, Somerton, SA |
| Dr Wm.C.Radford | Director | ACER |
| Dr G.A.Ramsey | Assistant Director | ASEP |
| Mr B.Rechter | Chief Research Officer | ACER |
| Mr G.W.Robins | Inspector of Science | Department of Education,Brisbane |
| Mr M.J.Rosier | Senior Research Officer | ACER |
| Bro.B.Scott | Science Master | Marcellin Col.Melb. |
| Mr S.R.Shepherd | Area Specialist | ASEP |
| Dr J.J.Smolicz | Senior Lecturer in Education | Univ. of Adelaide |
| Mr R.W.Stanhope | Tutor in Education | Macquarie University, Sydney |
| Prof.D.R.Stranks | Professor Physical and Inorganic Chemistry | University of Adelaide |
| Mr P.Sulzberger | Science Master | The Friends' School, Hobart |
| Dr M.L.Turner | Reader in Education | La Trobe University |
| Dr R.J.Vickery | Superintendent of Sci.Education | Educ.Dept. Perth |
| Miss K.Wall | Senior Lecturer | Westmead Teachers' College, Sydney |
| Mrs R.H.Wilkinson | Teacher Liaison Officer | ASEP |
| Mr R.H.Wilkinson | Senior Lecturer Physics | Univ. of Melbourne |
| Mr N.L.Wilson | Senior Research Officer | ACER |

## SUNDAY JANUARY 18

Official opening by Hon. N. Bowen QC, MP, Minister for Education and Science, followed by the first conference paper.

# AUSTRALIAN SCIENCE EDUCATION PROJECT

## GUIDELINES CONFERENCE

## OPENING SESSION - SUNDAY JANUARY 18

The Minister for Education and Science, the Honorable Nigel Bowen QC, MP, was introduced by Mr T.J. Ford, Acting Assistant Director of Secondary Education in Victoria, Vice-Chairman of the Committee of Management.

A summary of Mr Ford's opening remarks appears below. In an initial statement he apologized for the absence of the Chairman of the Committee of Management, Mr A.O. McPherson, who was unable to attend due to recent illness. In his remarks prior to introducing the Minister, Mr Ford expanded on the ideas presented in the following paragraphs:

Contrast can be drawn between a "Philosophy of Things" and a "Philosophy of Ideas" and words of common usage such as materialism, permissive society, altruism are related to these philosophies. We seem to be in an era where Things overwhelm Ideas.

It is difficult to make convincing measures in the field of production of Ideas, consequently the Project may never be able to make an adequate measure of its own success, may never be able to convince its sponsors and consumers as to whether it is a success or not.

However, it is interesting that this is a particular venture in that our major National organization, the Commonwealth Government, has seen fit to sponsor a major Project in the field of Ideas where it can expect no immediately tangible product.

It is my privilege to welcome The Minister for Education and Science and to ask him to formally open the Conference. I should assure him that this gathering is as fine and varied a group of Science educators as one could wish to collect. Its range is wide and deep; we can only hope that because of its diversity it does not come to uncompromising situations nor to compromises which produce a nebulous charter for the Project. I believe that we can guarantee you an optimistic start.

## OPENING ADDRESS

- The Hon. Nigel Bowen, QC, MP, Minister for Education and Science

Mr Ford, Ladies and Gentlemen -

May I first of all say how pleased I am to have the opportunity of being with you at the opening of this Conference and being invited to say a few words to you. Perhaps I should also thank you for the very enjoyable lunch which we have just had. I am particularly pleased to see such an expert and representative gathering which Mr Ford has described, gathered together for this Conference. I believe that this is a significant event in the history of Australian education for this is the first time that all the States and the Commonwealth have joined together to sponsor a curriculum development Project. Now the results of this Project are likely to be felt in most of the secondary schools in Australia, assuming it is fruitful and I hope it will be. That is not all. This Project should demonstrate the benefits of large-scale curriculum projects and I hope be the fore-runner of more such projects to improve the quality of education, both secondary and primary.

Education in Australia these days is a very large enterprise, as you people would know. There are more than 9800 schools both Government and Independent in this country - nearly 10,000 schools. Their total enrolment in 1969 was 2.7 million or 22% of the total population of our country and these children are taught by a teaching force of about 109,000 teachers. The expenditure on it is big money. The current cost, distinct from capital, Australia-wide in the 1968-1969 year was approximately $800 million, and the estimated expenditure of the 1969-1970 year $900 million. If one added the capital cost in the first of those two years, it was $204 million, taking that year to a thousand million dollars for education. The estimate for the current financial year in capital costs is of the order of $230 million.

Now, returning to the student population, which we have seen as 22%, I would suggest that one of the most significant developments in recent years has been the enhanced retention power of the secondary school. As recently as 15 years ago, 18% of the 15-18 age group were in full-time secondary education. The percentage in 1968 stood at 40%. That is from 18% to 40% in a relatively short period of time and I feel quite certain that that figure for retention in secondary school in that age group is going to continue to rise in the years ahead. Now this development results I suppose, partly from the rise of the general level of affluence in the community as a whole. Increasingly parents are able, though often not without sacrifice, to guarantee their children not only a primary education but a fairly good secondary education and there is an increasing awareness of the value of this secondary education and indeed tertiary education for their children amongst parents in the community.

The influence of these factors is reflected in the gradual upward extension of the period of compulsory schooling. The minimum school leaving age in Australia now stands around 15 to 16 years, so that it has been going up. Secondary school enrolments in the various States are expanding rapidly and much faster than the primary enrolments or faster than the growth in the population as a whole. While the Australian population between 1954 and 1968 grew by 34%, the secondary school population increased by 121% in the same period. In the same period, primary enrolments increased by only 43%. Now this in itself has imposed a very heavy burden on the secondary school system in terms of the provision of teachers, buildings and equipment, and everyone connected with Government is well aware of the pressures coming from this burden which has been imposed.

Another important aspect of the current situation in secondary schools is that the range of intellectual and other abilities of students passing through the schools, particularly in the senior years which havebeen extended (as by the Wyndham scheme in New South Wales) has broadened considerably. How to cater for the full range of talents in terms of what to teach and how to teach it has become one of the major problems of education systems.

Now in the past when the community at large was able to afford not much more than a rudimentary education for its children, or most of them, the question of what to teach was usually answered simply and fairly directly. The school syllabus was generally centrally determined, extremely detailed and rigidly enforced. There was not much opportunity for teachers to exercise initiative. The lessons tended to be formal with few concessions to any individual differences between pupils in interests or indeed in the rate of their learning. We know the picture. You had perhaps rows of pupils seated behind desks, the teacher before the class equipped with chalk, blackboard and even in some cases a cane, possibly wearing an academic gown for respectability's sake. The chalk, talk and drill was the method and sometimes the pupils even chanted their lessons in unison. I can remember a chanting of verbs in Latin and so on. The main emphasis was on the absorption by the pupil of a given set of facts and rote learning was the rule.

Such an education, though it was relatively primitive by our notions today, was not worthless of course. The cultural, scientific and industrial achievements of our fathers and our grandfathers' generations bear testimony to the rise in educational standards of their day. But characteristically mankind has not been content to rest on past achievements and standards and in the classrooms in the last few decades we have witnessed great changes in approach and in method.

I suppose in the first place the gradual improvement in teacher education has lessened the necessity for education authorities to prescribe every aspect of the school syllabus. Suggestion has tended to replace prescription. Teachers are now being encouraged more to make their own selections of material depending on their pupil's interests, and their own areas of special knowledge. At the same time psychology has shed some new light on the learning process itself, and more importantly, on the nature and extent of individual differences in type and in the level of ability. This has led, I suggest, to a shift in emphasis from teaching to learning, or as I would prefer to think, to a more balanced relationship between the activity of teaching and the activity of learning. Now old-time concepts of education saw the teacher more as dominant, almost as an actor performing before an audience, the child receptive but basically passive, but today we tend to see the child, I believe, and I emphasize the singular, "child", as a much more active participant. The child is after all an individual, and his intellectual, aesthetic and emotional development is the essential purpose of the education.

So we see memorization of facts per se giving way to the understanding of concepts, relationships and functions. I believe now we are seeing the gradual replacement of mass instruction by individual learning and here I should interpolate that these changes cost money. This Science Education Project itself covering only one fairly narrow aspect of the first four years of secondary school will cost the Australian taxpayer 1.2 million dollars. I believe he will get his money's worth and more but it is the kind of price which, multiplied many times over the whole field of education, the community has to pay in order to support current trends, modern trends in teaching.

We are witnessing also an extension in the scope and purpose of schooling beyond intellectual development alone towards a conscious approach to the formation of attitudes, and this is only realistic. The school child spends upwards of 6 hours a day at school and at the secondary level, he probably spends several more hours a week on school work, and the situations he meets with at school and the materials that he studies there and at home are bound to influence his attitudes, probably permanently. It is incumbent on educators therefore to ensure as far as they can that the young person is encouraged to develop an outgoing approach to others, take a full account of the desires and the feelings of others and to love his neighbour as himself.

It is my belief that the trends to which I have referred are desirable and that they should be supported and reinforced. A rising level in the education in the community is essential to Australia's continuing development, and I am not referring solely to the gross national product. I would emphasize the importance of strong and purposeful educational programmes in the sciences and technology which have played so vital a role in enabling mankind effectively to turn resources to account. I emphasize the importance of strength in this field. Our maximum returns are likely to be derived from education, if it provides adequate opportunities for individuals to develop their abilities to the full extent, and the Project with which you are currently concerned and are going to be dealing with in this Conference is directed towards that end.

After all, individual teachers and individual schools can do a great deal in devising special approaches and methods tailored to the particular needs of their pupils, but it seems to me as a layman, and I am very much a layman in this field I confess, the problem over all of designing curricula are much too numerous and wide-ranging to be capable of solution by individual teachers or even by small groups of teachers to the best advantage.

For one thing, the sum total of knowledge is expanding so rapidly. We are told that the amount of information available to the literate world is doubling each 15 years or so and no teacher on his own can keep up with this. Indeed I don't think teachers are fed as well as say a lawyer, with law journals constantly coming out or as well as a doctor.

For another, research efforts in say, psychology, education and related fields are resulting continually in new and changed theories of teaching and this is compounded by the fragmentation of teaching itself. You see books and articles being published on special educational problems of the physically and the mentally handicapped or the emotionally disturbed or the socially deprived or some other group, and any class of 30 to 35 children could include representatives of all or most of these groups. In such a plethora a normal child might seem almost unusual, but in the circumstances I have been outlining the scope for the large-scale effort in curriculum development involving a team of experts and drawing on the special knowledge of a wide range of consultants is obvious, and this is not to deny the right or even responsibility of individual teachers, as I said, to innovate in their own fields to meet the particular problems they are confronting. I am not advocating a return to the centrally-determined prescribed syllabus. On the contrary, I believe it is incumbent on those working on large-scale curriculum projects to provide for a wide range of individual differences to take account of the desirability of some diversity.

What I am suggesting is that a major curriculum revision is only likely to be successful if it is undertaken on a broad scale. The present Prime Minister recognized this when, as Minister for Education and Science, he offered Commonwealth Government involvement in curriculum development. The States, of course, are primarily responsible for their own efforts in this field, but the Commonwealth Government did feel that there were likely to be opportunities for efforts beyond the resources of the single State. It is therefore prepared to consider proposals and remains prepared to consider proposals for curriculum development projects, provided these are put forward by two or more States. A second aspect here is that there are obvious national economies in a co-operative project in which all or several States might participate, pooling knowledge and skills.

There should be several educational advantages to be derived from the large-scale project. A greater range and probably a higher level of expertise can be brought together to bear on the particular project. Secondly, there should be the opportunity to carry the exercise through all stages, encompassing the curriculum itself and the supporting materials, and thirdly there will be an opportunity to provide for a wider range of interests and abilities in subject matter, methods of presentation, and supporting materials. The result of the large-scale project could be a product of noticeably higher quality to the advantage of both teachers and pupils.

The large-scale cooperative project will of course be more expensive and more difficult to organize and carry through, and its project product will reach into far more schools and touch the educational experience of far more students. Indeed, the future of science curricula which will flow if you come up with fruitful guidelines which are then carried forward, means that the future in this field is to some extent in your hands for Australia, and it is something not to be approached lightly. The Project team, as a team and individuals, must be quite clear about their objectives and standards and keep these before themselves at all times. It is the purpose of this Conference to consider these matters and to lay down the guidelines.

I thought, having said that, I would like to leave one or two thoughts with you of a general nature, not original but I believe perhaps worth repeating. The first relates to relevance. I suggest that it is of the first importance that what is taught in any course and indeed in school generally should be demonstratively relevant to the students' own life, both in the future and in the here and now, and students will reject quite rightly that which they regard as irrelevant. I think it was George Bernard Shaw who said that his education was only interrupted by his schooling.

My second point is that all elements of schooling and hence this particular project must be concerned to create and maintain in the child a sense of curiosity and wonder in the world around him, such that he will strive for its preservation and betterment.

Thirdly, I believe that the school should encourage the child to involve himself in society and to feel a concern for his fellowmen, even if this falls short of going into politics.

Fourthly, the child should derive from his school experiences a respect for himself, born of the knowledge that he has a worthwhile part to play both in the school and in the adult world, which he will shortly join.

Above all I believe the schools must aim to develop in the individual child the ability to cope with life through providing the opportunity to plan the use of his time and to select activities. It is no good having a secondary school system that produces students who, when they go on to the university - a very narrow section of the world - find themselves completely unable to cope with it. Still less, to produce people who come out from schools or universities to a world which is materially very different and presents many more opportunities than the world did say 50 years ago, and find themselves unable to cope with it - going either into a mental home or to alcohol or drugs. There is a lack, I think, at the present time of relating the education sufficiently to the ability to cope with the modern world as we have made it today.

I hope that you will give some consideration to these thoughts as you deliberate in the course of the next few days and I would like to end my remarks by saying how pleased I am that this Conference is in fact being held. The concept of the Guidelines Conference seems to me to be a good one and in an enterprise such as this, with the complexity and duration of this one, the importance of adequate planning in terms of overall objectives, approaches and methods can hardly be overemphasized. I feel confident in the outcome of the Conference and of the Project as a whole, and I would like to say that I wish you well at this stage of the Conference. It gives me great pleasure to declare the Conference officially open.

# TRENDS AND ISSUES IN AUSTRALIAN EDUCATION AND THEIR IMPLICATIONS FOR THE PLACE OF SCIENCE IN AUSTRALIAN SECONDARY SCHOOLS

W. C. Radford
A.S.E.P. Conference, January 1970

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This paper is one man's attempt to isolate from the flux of change of the last decade some of those items and elements which he sees as having most significance for those in the next decade who, in secondary schools, will be concerned with learning science and learning about science, or with setting the conditions which will make that learning expeditious and efficient. Significance, that is, for the taught and for those who teach them.

I want first to discuss the social context in which secondary education takes place, because schools and what goes on in them cannot be divorced from that context, and in fact is determined to a great extent by it. I want then to discuss trends and issues at the system level, referring particularly to contrary tendencies in centralization, to relaxation in prescription, and to the development of a national outlook. A consideration of school and class organization will follow. It will need to be concerned amongst other matters with the increasing freedom and autonomy of schools, with the relation of curricula syllabuses and courses of study to community and individual needs, and with integrated curricula. Teachers will then be dealt with under aspects such as the quality and extent of training and preparation, their dilemma in choosing between objectivity or neutrality and commitment, their role in choosing experiences adapted to their students and the community they come from. I will at appropriate points relate the matters referred to to the purpose of this conference - Science education for the junior secondary school pupil.

## The Social Context

I begin therefore with a discussion of what I think are some of the important features of our social context which education cannot ignore.

We live in a political democracy with considerable freedom of expression and considerable freedom to convince others, if we can, and need to, of our point of view. We have some say in the social and other policies which guide or regulate our private and our public life. Our belief in the system rests upon a faith that men and women can make rational decisions when presented with argument and counter-argument, are able to recognize and then to separate truth and falsity, are willing to seek out evidence or to suspend judgment in its absence, can recognize that often their judgments between possible alternatives rest upon sets of values which are only partly the distillation of their experience and can therefore often not be wholly buttressed by evidence, and can accept that although social conditions affect behaviour in ways that are largely preditable, there are still many aspects of human behaviour in groups and in society which are not predictable with any certainty. Social and economic policies by their nature are forward looking, and new policies rarely have experimental evidence about results to guide them. They may be, of course, and often are, based on facts collected over time in an unplanned way, or on facts gathered specifically, and according to a plan, as a basis to determine policy.

For such a system to run with moderate efficiency and with satisfaction to all, it needs people with many different kinds of competence according to the level at which they operate - advising on policy, determining policy, implementing it and just plain living with it which is what most of us have to do. It is for the last named level that the great majority of us must be prepared by our school and post school experiences. Some few of us will be as expert as the advisers and the policy makers : the rest of us will have at our disposal, in appraising the quality and effect of policies, powers of observation, ability to organize and interpret observational and other data, ability to communicate orally and in writing, willingness to organize and to use the social machinery available to us to discard, or to alter the policy, or to find it good enough to warrant effort in its improvement.

I have spoken as though the matters of concern were public governmental policies only : I do not want to limit them in this way, because there are policies operated by our commercial and industrial concerns, our commercial mass media which are under minimal social control but which affect our present and future life and about which we need to exercise the same kind of competence in appraisal that we should exercise constantly about public policies.

By the time they leave school the majority of the population will have had all the formalized and externally controlled learning of any subject, including science, that they will ever have. Some will dabble in special fields, some will continue personal and private enquiry in matters of interest, but for most their future contact with those aspects of the study of the structure and operation of inanimate and animate things, which we at present deal with as science, will be limited to the occasional newspaper, magazine, or television programme. Given this situation what contribution can the scientific knowledge, skills and understanding obtained at school make to the effectiveness of an individual's participation in our society?

Because of the complexity of the society we live in, and the great variety of problems, policies, and social and other practices affecting the individual in that society, educators have responded by trying, before the majority of children leave school, to give them some understanding of a number of the fields of knowledge upon which those problems, policies and practices rest. I do not need in this setting to go into detail of such facets as health, consumer education, the study of society, the expressive and creative arts, the study of literature and of communication, and the study of science either in its several disciplines or in integrated form. Nor do I need to explain further other more general objectives behind the selection of the sum of the school experiences : the objectives of developing the attitude of interest in further study and learning, the habit of enquiry, the practice of suspended judgment on decisions where this is possible until data is available, the acceptance of the need often to act on the basis of reasoned analysis of data because it is not possible to conduct many social experiments in miniature.

The informed and participating citizen is a protean figure. There is no immutable formula for his creation by formal education. There is no doubt that because informed public discussion of the problems constantly arising in it is regarded as essential in the kind of society we at present prefer, and because these problems cover the whole gamut of human knowledge, the trend in recent years has been towards as broad an education as possible, and as little specialization as possible, up to at least the end of the tenth year of schooling. We are uncertain as yet about the respective places of knowledge of facts, generalizations, principles and so on, of skills in using them, and of the attitudes and habits of thought that grow with and upon them. So far as science is concerned, it takes its place in the curriculum of studies and experiences because the routines of our lives, and the very organization of our society, rest on applications of the knowledge it has acquired, andbecause we now have no doubt that before the end of this century, and well within the lifetime of the children we are intending to affect by our deliberations here, increases in knowledge and in its applications will alter those routines and may require some reorganization. To leave a participating citizen ignorant of the nature of that knowledge, at least some of its key concepts, and of how these have been acquired and put to use, seems to us to be inhuman.

"H. G. Wells used to write stories" Bronowski wrote in 1956 "in which tall elegant engineers administered with justice a society in which other people had nothing to do except to be happy. But a world run by specialists for the ignorant is, and will be, a slave world. By leaving science to be the vocation of specialists, we are betraying democracy...." (Quoted in UNESCO's Courier August-September 1969, P.62)

More and more are staying at school longer and longer. We are not quite at the stage where we can claim that the folk-hero is one who has made his way in the world despite the fact that he left education before he completed his postgraduate studies, but the idea is there!

We live in a time of rapid change in the use of machinery to help us to control and to use our environment in order to improve the comfort of our living and the speed and effectiveness of the work we do for that purpose. To understand that machinery and to service it, to improve upon it for the purposes it serves, to develop new applications of available knowledge of nature, man and machines - and to understand and improve the operation of the many new controlling, executive and servicing functions that have developed along with the machinery, we have needed to develop new skills and to improve on old ones. It is difficult to know whether it is these needs along which have led to a rapid increase in the average length of schooling, or whether other factors have also had some influence, or whether it is the availability of children with longer schooling which has led to the lifting of qualifications for many occupations entered direct from schooling as well as those expected from those entering higher education.

It is not easy to know whether it is specific knowledge, or skill, which is looked for by employers or those providing further or higher education and if so at what level, or whether it is some combination of physiological maturity, attitude, social poise and general knowledge which is sought - either because it is sufficient in itself for present and foreseen needs in the particular occupation (which is improbable) or because in the employer's view (and probably experience) this combination is a good predictor of ability to learn the specific occupational skills, and to deal successfully with the further study required to advance in the occupation.

If specific skill or knowledge is sought we do not seem to know what it is; if it is the level of personal development, we do not know what part particular subjects play; if it is the predictive value of the combination, the weights of the several elements are unknown. In this situation it is not possible to know what the specific value of any particular subject is unless it is required as a prerequisite to further study of the same subject; even then we need to be certain that the further study requires the preliminary work and cannot proceed without it.

I find it difficult to separate, in my own thinking, the responses to the two related trends of longer schooling for a higher proportion of the population and the demand for higher qualifications. The trends have been towards a more general curriculum in the early secondary years, and for either adaptations of existing courses, or the development of different courses, for those finding little success in dealing with courses designed for those aspiring to further education beyond Grade 10.

There have been two principles embedded in this trend, sometimes implicit rather than explicit. The first has been a combination of a belief in the value of a common and a general education for all so that there would be a common basis for communication among the members of the Australian community and of a belief that while at school the adolescent should have a degree of success in studies that were relevant to his assessed needs and appropriate to his ability and to his desire to benefit from school. The second principle has been to keep options open for appropriate later studies as long as possible, so that those continuing to the end of secondary schooling would not be penalized by mistakes in earlier selection of subjects.

It is not difficult to discern increasing doubt about the suitability of much of the content of the subjects that still form the staple of secondary education and whether the greater part of the curriculum in the secondary school is relevant to the present needs of the majority of adolescents.

And as a higher and higher proportion of a generation completes secondary school and enters a greater variety of occupations and of tertiary institutions, with new and different needs and courses from those to which we have been accustomed, there is less disposition to accept the purpose of the last two years of secondary school as mainly a preparation for a terminal examination which qualifies for further study, and to see those years in very much the same light as the earlier ones : that is, concerned with a general education primarily concerned with the development of the informed and participating citizen rather than the informed and aspiring member of tertiary educated elite. We have passed through, or are nearly through, the transition phase between a complete secondary course designed as preparation for tertiary studies and a complete secondary course seen as one of general education for all - a transition stage in which the first part of secondary was seen as an educational stage in its own right, and the later part as preparatory. We are approaching the stage where all interests are to be served, whether these are for maximum personal benefit from the broadening effect of studies of man's social, spiritual, and material achievements and errors, or for the intensive and deeper study and understanding of particular areas of knowledge, or for the development of greater skill in performing some process such as artistic or verbal communication, or the interpretation of the performance of others. The specific needs of those aiming for further education will not be overlooked, but they will be more varied than they were, and the prestige of the studies they undertake will be less exclusive, although still important.

The technology which applies to our human condition the advances in knowledge made by scientists anywhere in the world, is ubiquitous and so are the problems which it has created. Many of them have been unforeseen, and the ill effects of uncontrolled use of knowledge have been slow to appear. Whether they have created problems or not, the uses of knowledge through technology have changed, are changing, and will change our environment. I believe the awareness of the effects of the uncontrolled applications of knowledge, and the applications in ways not foreseen by those whose work produced the knowledge and the ways of applying it for human purposes, have led many scientists themselves to a commitment to several interrelated views:

> That knowledge is no man's preserve and that its use should benefit all regardless of affluence or nationality;
>
> That those who produce the knowledge cannot remain indifferent to the uses to which it is put, and have an obligation to speak out about its uses.

The passionate search for truth to which they are dedicated must be accompanied, many feel, by an equally passionate concern for all humanity who are heirs to that truth. If, as seems true, the other studies engaged in by schools do not lead to such concern, then those who teach and learn of and about science must accept a direct responsibility, and adopt the development of concern about how its applications are used or are to be used, as one of their objectives. To include teaching and learning about such matters as pollution or conservation is not, they believe, enough : neutrality and lack of commitment to improve current situations are not acceptable.

This may not be clearly enough documented yet to be a trend; it is, however, a real issue, and one that I believe no attempt to teach science can now ignore. On it, a stance must be taken.

While I am discussing this kind of social involvement of the scientist in the effects of his work, I think I must refer also to the view that many of the problems of modern society may be resolved by the same processes of observation, analysis, interpretation and presumably experiment as have been used with non-human materials and by scientists with the same kind of training. I find it difficult to believe that a study in depth of atomic fission is a preparation for resolving problems of urban renewal, or of synaptic transmission a preparation for resolving the problems of human aggression. The idea, however, does raise the issue whether science as at present conceived as a school subject ought to be more widely conceived to incorporate many aspects of what we at present call social science. It would lead to some interesting views on the nature of knowledge, on the variability and invariability of human behaviour under varying external conditions, and on the transferrability from one field of analysis to another of processes and concepts. Who would provide the outlines of problems to be considered and the principles, generalizations and syntheses to be dealt with?

Scientists themselves need to be aware of views about some of the spectacular achievements arising from their work. I have time for several only..

Quoted in Phi Delta Kappan Sep. 1969, Editorial P.1

> Ralph Abernathy :
>
> " A society that can resolve to conquer space, to put a man in a place where in ages past it was considered that only God could reach .... deserves both our acclaim and our contempt .. acclaim for achievement and contempt for bizarre social values. For though it has had the capacity to meet extraordinary challenges, it has failed to use its ability to rid itself of the scourges of racism, poverty and war."

> Lewis Mumford :
>
> "Any square mile of inhabited earth has more significance for man's future than all the planets in our solar system. It is not the outermost reaches of space, but the innermost recesses of the human soul that now demand our most intense exploration and cultivation .... The prime task of our age is not to conquer space but to overcome the institutionalized irrationalities that have sacrificed the values of life to the expansion of power, in all its demoralizing and dehumanizing forms.

There are many other aspects of the social context that I should deal with at length, but will not because of limitations of time. I merely list them as necessary for consideration and for the working out of implications.

We are more concerned than heretofore about the underprivileged families and the children who come from them, and more familiar with at least some of the deficiencies and differences in language, in concepts, in modes of analysis, and in attitude, which arise because of the relative poverty of such families.

Our adolescents are closer in experience to adults than we were as adolescents to our adult seniors, and probably more knowledgeable. Their out-of-school experiences are probably more educative, in all sorts of ways, than we can understand; their awareness of technology and its effects and their readiness to accept that knowledge is constantly being added to, makes a potentially very ready group to work with.

Lifelong education is as yet for most of us a theory rather than a reality, but there are already occupations which we knew which have almost disappeared, and many that we know nothing of at present will be engaging our children's children. Change in needed skills, innovations in organizing knowledge, and greater leisure for the use of personal skills in the service of private interests will require the elaboration of post-school education on a part-time as well as a full-time basis. We can look to our schools being much more extensively used, and much more expensively equipped, to serve such needs, and it is inconceivable that in such settings school education will not benefit from the more direct association between school and community.

Lastly, schools are now operating in a context of public concern about education which has not been experienced for many decades past. Parents are divided in their views. Some are satisfied with what their children are doing, and how they are developing. Others are not. Those who are dissatisfied have, for the most part, had their dissatisfaction whetted, if not initiated and developed, by professional realization and discussion of the gaps between recognized possibilities and actual achievement. Although most of the dissatisfaction is at present directed to material things, not all of it is, and there is a growing interest in the nature of curriculum and in the specification of its objectives.

## System Trends

May I move now to trends and issues at the system level. As I indicated earlier, I want to deal with apparently contrary tendencies in planning and in curriculum development. The apparent contradictions are these between the growing involvement of the Commonwealth Government in matters related to non-tertiary education, and the increasing freedom being given to schools in all kinds of matters; between the growing sense of the need for co-ordination and control over developments in tertiary education, other than teachers colleges, at both Commonwealth and State levels, and the growing sense of the need to give more responsibility to local communities and to the local principals and staffs of schools, in primary and secondary education. I referred to them as apparently contrary tendencies, because I do not think they are really opposing ones. What I think is happening is that centralized control as we have known it, exercised through the States in regard to primary and secondary schools, teachers' colleges, and some aspects of technical tertiary education is being increasingly felt to be inefficient by all those involved because it makes insufficient use of the capabilities of qualified individuals in the institutions which are the kernel of the process of education, while we are still seeking out those matters on which in the interests of the pupils, or students, co-ordination is necessary to ensure real equality between the institutions.

Economy of scale, rationalization of resources, efficient systems of control are being expounded on the one hand by management theorists concerned with government and industry, along with the encouragement of initiative and the development, through responsibility, of individual talent. In education administrative theory appears still uncertain of its stance as regards the professional freedom of the individual teacher and the degree of control to be exercised by the community over his activities.

Because we have become accustomed to look hard at centralization at State levels, and to seek out ways in which greater freedom can be given to the individual school and teacher, we are prone to look with suspicion at any moves which appear to imply control, or direction, or co-ordination at the national level, tending to see in these, at a point more remote from direct concern with students than a central State authority, a reimposition of a type of control which the States see it necessary to loosen, if not to abandon.

Yet at the same time there appears to be growing steadily a national outlook. Collaboration between States is increasing and consultation between Commonwealth and States is becoming a matter of course on an increasing range of matters. Professional collaboration is more frequent : people move more easily across State boundaries : ideas are common property as they have not been before : Canberra is in the news more frequently : the very conflicts between State Premiers and the Federal Government underline that we are one country and underscore the irrelevance of State boundies in many issues.

Children in our schools, and students in other educational institutions, are Australians. I believe this common factor is looming larger in all our thinking, and particularly in thinking devoted to the courses of study in subject areas, or the selection of areas of study where subjects are not popular. We still of course for the most part develop curricula and their separate parts on a State basis because that is how our systems are organized, and overall system organization is on a similar basis. Any moves to decentralize administration, or to give freedom to individual schools, are still within the framework of State laws and regulations. The trend is clearly, however, towards more collaboration between authorities in the several States to ensure that ideas and experience are shared, while transferring within the States greater and greater responsibilities to community and to teacher. In much of the collaboration the Commonwealth plays no part, and never has done so, but the establishment of the Ministry and the growing interest in education both initiated by and forced on the Commonwealth Government has produced mechanisms for collaboration between governments which encourage and facilitate it. As I see it, therefore, we tend to think now about curriculum in more Australia-wide terms than formerly, and with more interest in what others are doing, but still insist that each unit of administration has the right to choose what it should do about curriculum in terms of its components, its, prescriptions on content and times of study, and its organization. If the unit of administration for curriculum is the State, this may mean prescription of a course of study; increasingly at the junior secondary level for particular courses it means that choice of courses of study in particular subjects is the prerogative of the school, with advice and assistance being provided by a central administration through consultancies and advisory systems, and the provision of uniform facilities. I believe there are several issues here to which insufficient attention has been given, and I can refer only cursorily to them. One is the case for and against a centrally prescribed as against other approaches to school curriculum, with complete freedom to the individual school as the other extreme. A second is that of evaluation when freedom is widespread; and associated with evaluation the applications of educational sanctions. A third is the preparation of teachers when freedom for the teacher is a reality. Behind all of these is the function of the community as a whole in determining objectives and allocating resources, and the extent to which it is prepared to allot responsibility for attaining system, school and subject or specific content or process objectives to professionals with various responsibilities.

If it be held that a school selects its objectives, is it within any general framework, and where is this to be found? Who builds it? Who is the school - principal, or all or a segment of staff, or parents, or pupils, or some combination of them? If a teacher may choose what he teaches, and to what end - which is implied in most of the statements one reads about freedom in choice of curriculum - are there no limits or checks except his own? Are any controls needed? Are there any at all, or are there controls by colleagues in other subjects, or in his own subject, or in his own particular group of colleagues if he is a member of an integrated general studies or integrated curriculum programme? It is all very well to say that one should trust the professional integrity of the teacher. I would - but only because I think there is still some general consensus about objectives. We can give freedom to an individual school or teacher, I think, only within such a general consensus. Otherwise we give too much power over other people's lives to an individual who can be idiosyncratic without those whose lives are affected being able, for the most part, to do anything about it, or to know until it is too late, that they were being guided in idiosyncratic ways. In the extreme form it is not hard to see this situation:

> A teacher who is never evaluated by any competent colleague, who is free to teach what he wants to, when he wants to, for any objective he chooses, to children who are compelled to attend, who have no means of knowing whether their fare is good, bad or

indifferent, and who have no form of external evaluation to refer to, where there is no 'market judgment' on a teacher, and dismissal for incompetence is rare.

Truly we place a tremendous reliance on pre-service education, in-service education, and professional integrity. They must be very good indeed to give us the equanimity we should have that all children are receiving a broad education of good quality and not a narrow conditioning based on a very limited offering of knowledge and experience.

## Preparing Teachers

Those who prepare teachers for their work in secondary schools, to teach science, have no easy task, and must, in fact, live with a great deal of uncertainty. I am not referring to the scientists as such, dealing with science and teaching it at tertiary level in universities, in institutes, and in colleges. I know that many of them are uncertain about what should be in their courses, and what sort of person ought to be coming out at the end of it. But by and large few of them have expressed publicly any concern about what I think are the principal objectives - to prepare someone who knows enough about his particular brand of science to be able to apply it usefully.

It is those who are preparing scientists of this kind to teach children about science who must be uncertain. They must prepare their students for situations ranging from following a course to creating one, from the most formal teaching situation to the most unstructured one of joint seeking after knowledge. They must be concerned with alternatives in methods of presentation to human subjects ranging in understanding from complete ignorance and naivete to something often like sophistication and mastery. The presentation may be of content or of process, it must take full account of the different needs of the children receiving it, their different modes of learning and their different rates of learning, while at the same time it must ensure some degree of common understanding. They must prepare a teacher to take complete responsibility or to be a member of a team taking responsibility at a particular level or for some aspects only of a course ranging over various age and form levels. They must help them to a more complete understanding of the fundamental concepts and knowledge and skills relating to the disciplines in which they have spent their tertiary study, and, in terms of the view I took earlier about the social concern of the scientist, to be informed about the social consequences of current applications of the knowledge of their disciplines. And as though these complexities in preparation were not enough these teachers must be made competent to evaluate their own performance as teachers in terms of their chosen objectives, through measurement of the growth in knowledge, skill, understanding and attitudes in their students.

The trend over recent years has therefore been away from any specific methodology of teaching, with more attention being given to the nature of the child and his needs, and to the processes by which scientific knowledge is added to. The issue is still what is the best combination of knowledge, understanding of process, and attitude towards science for each individual student, if science is to be a crucial factor in his development as a person.

Well, there it is. Let me recapitulate, briefly, the trends and issues I have referred to.

## Conclusions

The informed and participating citizen is receiving more and more a broad general education to equip him to help to formulate or to understand or to evaluate policies and practices in the society of which he is an active part. In addition to general qualities such as ability to assess and interpret evidence which science is attempting to develop, specific knowledge is being given of the key concepts of science of which the applications are affecting the routines and organization of our personal and social lives.

More education is being sought by more people both for the better qualifications needed for an increasing range of professional, technical and service jobs, and for the qualifications expected for many of the jobs which in earlier years were adequately handled by those with less education, and for their general education. There is growing doubt about whether courses of study of the traditional kind are necessary even for preparatory studies for those proceeding to further education, and growing certainty that they are not the best for the general education required by the increasing numbers staying on to complete secondary education but without specific further study in mind.

The first three or four years of secondary education are no longer seen as necessarily preparatory for the last two, but are setting the fashion for more and more studies of a general nature in the last two years. The principle of greatest benefit for the greatest number is, as the percentage of a generation completing secondary education increases in size, leading to a reappraisal of the nature and purpose of the curriculum of those final years.

Scientists are no longer content to be neutral on social issues arising from their work and the increased knowledge it brings. Teaching about the social consequences of applications of science is becoming as important as teaching science and about its applications. And approaching social problems with the procedures which have added to knowledge in inanimate or non-human nature is being advocated by more of the latter kind of scientist. The inclusion of those aspects of social science which use procedures acceptable as leading to permanent additions to knowledge, as a part of the study we call science is likely to be an issue of considerable moment in the not too distant future.

Concern with the deficiencies of the underprivileged, awareness of the smaller gap between the educated adolescent and the adult of less education and somewhat wider experience, lifelong education, and public concern with the kind of person "put out" by the education system are all trends containing issues which concern experiences in science.

Greater freedom is being given to individual schools and teachers in choice of courses and approaches. The extent to which this is compatible with equality of opportunity for all pupils is an unresolved issue. So too is the extent to which the individual teacher can express an idiosyncratic viewpoint except within a general framework of consensus. The prospective teacher under tutelage needs induction into a very complex set of skills in both understanding and action. Methodology in presentation is no longer enough. Individual child needs, applications of science, and the social consequences of such applications must now concern every teacher, and therefore play a part in his preparation, just as does an understanding of the relation of studies in science to other school activities.

May I conclude on this note. Not all subjects are international as I believe science is or can be. The languages of science and mathematics are universal. Just as there is no such thing as regional science or a regional mathematics, there is no such thing as national science and national mathematics. It is a personal view that probably only through such studies, with due stress placed on the lack of national boundaries in them, will the deep conviction that mankind is one govern policies and practices in all human affairs. Then, perhaps, we will learn to live and to work together without regard to national boundaries, as we will, I hope, work in this week-long meeting without regard to regional ones.

# AUSTRALIAN SCIENCE EDUCATION PROJECT

## GUIDELINES CONFERENCE - JANUARY 1970

## Some Trends and Issues in Australian Education

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I have prepared the following list of a number of trends and issues in Australian education as a general background to my paper. I will refer to some of the topics listed, but not to a great many. The list may be of use during the deliberations of the Conference as a reminder that the development of materials for science education is taking place in a changing scene. Participants will undoubtedly want to add to it. I have left space after each section for this purpose.

WCR

## STUDENTS

1. Extension of period of schooling - compulsory and voluntary.
    a) Changing characteristics of the upper secondary school population.
    b) Changing motives for desiring further education.
2. Different experiences outside school because of mass media and other technological changes.
3. Greater complexity in the society they face and therefore both more need for guidance and more concern with strength and independence of judgment.
4. Different aspirations and expectations in terms of material things, responsibilities, participation etc.
5.
6.
7.
8.

## TEACHERS

1. Longer period of training for primary teachers, and a different kind of training. Effect on children from primary school.
2. Different kinds of training in education for secondary teachers of traditional subjects, and a greater variety of types of training amongst teachers in secondary schools.

Teachers (Contd.)

3. Higher percentage of young teachers.
4. Shortage of specialist teachers in subject fields - such as graduates in Science, Mathematics, English.
5. Teachers' concern about their role and effectiveness. Unrest about this, and lines of action proposed.
6. Desire for greater independence and autonomy.
7. Growth of professional feeling. Rise in importance of subject associations.
8. Ancillary staff. Idea of a hierarchy of teachers in a school based on prior training and special skill.
9.
10.
11.
12.

## CURRICULUM

1. Change in Primary School e.g. Science, Maths.
2. Concern about subject separation and presence or lack of boundaries; and therefore moves for new curricula.
3. 'Relevance' of subjects, and of content, under question. Relevance for what is NOT clear.
4. Objectives of whole curriculum and its parts are under review and assessment of achievement related to those objectives.
5. Schools are seeking and being given more freedom in choosing curriculum, subjects, syllabuses, and courses.
6. Alternative curricula and courses are being provided to suit both interests and assessed ability.
7. General education rather than specialist preparation appears to be popular with teachers, but the community is unsure about it.

Curriculum (Contd.)

8.

9.

10.

11.

12.

## METHODS

1. More attention to individual differences but uncertainty about how to deal with them.
2. More pupil activity and independent study.
3. More classroom discussion and inter-pupil self help schemes.
4. Relation of method to architecture of buildings and the planning of accommodation : libraries, laboratories, stores, equipment itself, movement space.
5. Specialist versus General Teaching including Team Teaching.
6. Evaluation of achievement and relation to methods used with individual children.
7.
8.
9.
10.

## SYSTEM AND SCHOOL

1. More autonomy for principal and staff.
2. Decentralization.
3. Removal of external examinations and of frequent assessment.
4. Development of in-service education.
5. Personnel relations being studied more closely, and role and expeditiousness of communication given more attention.
6. New methods of curriculum innovation.
7. Improved facilities and data for planning, including research.
8. Diversity in tertiary institutions and questioning both of the mode of preparation for them and the nature of their own offerings. Greater attention to transition period and its problems.
9. Centralizing versus Decentralizing tendencies.
10. Use of technology such as ETV, programmed instruction, and computers in instruction.
11.
12.
13.
14.

## GENERAL

1. Questioning the role of the school as a social and educational institution.
2. Greater public and political interest in and concern with education.
3. Mounting volume of professional, technical, and popular publications about education.
4. Interest in administrative theory and practice. Apparent conflicts between "economics of scale" and need for autonomy for professional group.

General (Contd.)

5. Relationship between educational effort and social and economic development.

6. Interest in general purposes of education and the tension between various outlooks:
   e.g. "social demand" versus "manpower".

7.

8.

9.

10.

WCR

January,1970

## MONDAY JANUARY 19

The broad aims of the Project and some implications from other curriculum development projects

morning: two papers and commentary
afternoon: syndicate discussions
evening: plenary session

# THE PURPOSES OF THE

# AUSTRALIAN SCIENCE EDUCATION PROJECT

Appendices : A. Ministerial press release.
B. Organisation chart.
C. ASEP committees.
D. Project activities.

## 1 Introduction

1.1 The Commonwealth Minister for Education and Science, in a statement released on 30th November 1969, reviewed progress made in the establishment of the Australian Science Education Project (ASEP). A copy of the statement is at Appendix A.

1.2 The intent of this paper is to review the purposes of ASEP, to note the opportunities available to the Project, then record the rationale proposed by the executive, discuss certain major considerations, and, finally, state the broad plans proposed for the operation of the Project.

1.3 In this paper, "purposes" is used only in connexion with those determined already. These purposes are listed and discussed in Section 2 below.

1.4 It appears necessary, at the outset, to state the beliefs of the ASEP executive about the phrase "curriculum development". We believe that curriculum development, in the sense of designing the child's total educational experience at school, should be done at as close a range from the child as is possible. The total curriculum should thus be decided in schools to meet the broad educational aims of the schools. These aims should reflect community expectations and student needs and aspirations, while taking into account the stage of development of each child. These aims will vary from teacher to teacher, school to school, and State to State. For the executive to presume some over-arching national philosophy of education, or to decide what the national aims of education are, or should be, seems to be an academic exercise quite outside its charter. It is recognized, however, that the executive has a philosophy of education which must influence the direction of the Project. This philosophy will not be stated, but may be surmised from later statements regarding science education.

1.5 Whereas the executive does not see itself in a position to presume a national philosophy or decide national aims, it does believe that it has a charter to explore the possible contributions that science education, at this level, can make to any total curriculum, and to define what these contributions might be. By describing possible outcomes of learning experiences in science, and by structuring these experiences in a meaningful way, it can help teachers and schools decide which learning experiences best fit the curricular demands of their particular school. In this way, ASEP materials need not prescribe what should be done but, rather, describe what could be done.

1.5 (Contd.)

They will offer choices from which teachers may select. To guide those teachers who may require it, sequences of experiences will be outlined from which a science course, in the usual sense, could be arranged.

1.6 The executive believes that curriculum development is a synergic process, that progress results from the co-ordinated effect of a number of interacting elements. Thus a stimulus applied to any element will cause interactions among all the elements. If the correct stimulus is applied, progress will result. Whereas the Project will not attempt curriculum development ab initio, it will apply a stimulus resulting in curriculum development.

## 2 THE PURPOSES

2.1 The Commonwealth and the States of Australia have determined that the purposes of the Australian Science Education Project are:

1. to develop instructional materials in science for use by teachers and pupils in grades 7-10 in Australian schools,
2. to carry out such evaluation of current practices in a cross-section of Australian schools as is necessary to ensure that Project materials are tried in a variety of situations where the characteristics of the school, teachers, and students have been adequately described,
3. to produce suitable evaluative and descriptive instruments designed for use with Project materials,
4. to develop a model of a teacher education program for the implementation of Project materials in schools, and implement it in conjunction with teacher education authorities throughout Australia, and
5. to establish a specialist resource service for the developers of Project materials, for trial teachers in schools, and for other teachers interested in Project materials but who may not be using them in the trial situation,

and that outstanding priority is accorded by all States to Purpose No.1, the other four purposes to be fulfilled only in relation to the materials that are being developed.

2.2 The executive interprets the phrase "instructional materials" as being comprehensive. It is taken to include printed matter, both verbal and non-verbal, equipments, specimens, and audio-visual aids of all kinds, for use by teachers or students.

2.3 Whereas there are many ways in which the finance made available may have been used in connexion with science education at the junior secondary level, the purposes stated above represent a consensus of the contributors as to the best way of applying the resources. Basically, the contributors accept that a

2.3 (Contd.)

pooling of resources is more likely to achieve results than if the same resources are fragmented. Further, the contributors believe that whereas each purpose is of vital importance it is essential that an adequate proportion of the available effort be devoted to the development of instructional materials. A continuing task of the executive will be the maintenance of a balance of effort to the various purposes.

2.4 It should be noted that the Project has not been charged with responsibility for final publication of printed matter or production of other materials. Decisions on these functions will be made at a later date.

## 3 THE OPPORTUNITIES AVAILABLE

3.1 The resources, based on the finance provided, available to ASEP are greater than ever previously available for such a project in Australia. There is provision for full-time staff, for a number of committees, for the employment of consultants, for the supply of equipment, and for time.

### Staff

3.2 The organisation chart, at Appendix B, indicates the extent of staff that will be available. The peak number of full-time staff will be about 50, of whom a relatively small proportion will be employed on administrative and unskilled tasks. An early estimate, for costing purposes, has been made that between 20 and 30 million sheets of paper will have to be printed to allow reasonable trials of printed matter. The preparation of masters and the printing, collation, packaging and despatch of this amount of material will be a formidable task.

3.3 A significant area of staffing is that entitled production. The full-time involvement of a photographer, an editor, a graphic artist, a laboratory technician, and an audio-visual technician, exemplifying the advantages of pooled resources, should ensure high quality products.

3.4 It is the hope of the executive that the large number of professional posts will be filled by well-qualified persons from various States and educational systems, and with a variety of interests.

### Committees

3.5 Committees have been formed. Although they appear to be numerous they all cater for the needs of the Project.

3.6 At the grass-roots level are six State Advisory Committees. There is a Central Advisory Committee. Within the Australian Council for Educational Research there are two committees, one dealing with professional matters, the other with business matters. The national Committee of Management has final responsibility for the Project.

3.7 Appendix C gives further details of ASEP committees.

## Consultants

3.8 Provision has been made for the employment of consultants. The Project will determine the number and kinds of consultants as the needs are revealed.

## Facilities

3.9 Funds provided will ensure that adequate facilities will be available to the staff of the Project.

3.10 In the belief that a large gap between the quality of production of trial materials and that of final commercial materials might contaminate evaluation studies of the trial materials, the executive will strive to achieve a high standard of production with trial materials. Its efforts will be assisted by the availability of adequate reproduction facilities, an engineering workshop, a laboratory, and photographic and audio-visual equipment.

## Time

3.11 A most significant resource, even though it is limited, is time. The planned duration of the Project provides very limited time for initial planning. This Conference was authorised as a means of overcoming the shortage of time available in the early stages. But planning will continue for three years after the Conference so that the total time for planning appears to be very adequate.

## 4 RATIONALE

4.1 The executive would like to have been able to base Project activities on established positions relating to the philosophy, aims, goals and objectives of Australian education. This has been proved to be impracticable. It is therefore necessary to declare the beliefs, shared by members of the executive,which might constitute the value judgements on which the work of the Project will be based. This Conference should confirm, amend or add to the beliefs stated in this rationale.

4.2 Whereas the executive does not offer any comprehensive philosophy of Australian education, or attempt to define its aims, it does have certain specific views about the educational process and about the nature of science which will influence Project activities.

4.3 We believe that education, as well as being for living, is part of living. We believe that living is becoming more complex because of the growth of total human knowledge, the increase in the range of human skills, and the pressures of the technological way of life. Formal education cannot hope to do more than sample the possible range of educational experiences. At least in respect of those pupils who leave school early the sample must become increasingly smaller as a proportion of the total. If, then, formal education is to involve some learning experiences that are vital to every citizen it is essential that we establish criteria to enable us to determine priorities.

4.4 We believe that science now has a unique obligation to mankind arising from the fact that it is the basis of technology and is therefore responsible for having provided the opportunities for the generation of social issues such as pollution and the road toll. Science education must, on behalf of science, accept an obligation to make its contribution towards resolving such issues. Science education can make a special contribution through the development of an inquisitive attitude, a respect for evidence, and a rational process of decision-making.

Science in the Junior Secondary Curriculum

4.5 We believe that all students in Grades 7-10 should study some science. The amount of science to be studied should be decided by the school according to its needs. The Project will attempt to develop sufficient science experiences to occupy up to 20 per cent of the time a child spends in Grades 7-10 in three States, and at least 20 per cent of the time he spends in Grades 8-10 in three other States.

4.6 We believe that science is worth studying because it forms an important part of our cultural heritage, because it provides a substantial body of knowledge relevant to life in modern times, because children get enjoyment out of science learning experiences relevant to them and for the special way the methods of science can be used to describe and understand the environment[1]. We believe that exploring the environment is an important part of each individual's development, and that if this exploration can be directed in a scientific way, the individual will achieve an important set of reference points for looking at the world.

Learning from Phenomenological Experiences

4.7 We believe that phenomena which can be presented within the immediate experience of the child are the ones that are likely to be most meaningful. This is particularly true for children in Grades 7-10. We believe that the scientific examination of phenomena allows children to learn about the world in a number of different ways. They can learn individually as they observe and operate on learning experiences provided. They can discover that much of science is haphazard, with occasional flashes of unifying insight, and that much of scientific investigation is just plain hard work. We believe that all children can have these experiences, provided the learning situations are carefully designed. They can learn as individuals by describing, classifying, experimenting, hypothesizing, testing; that is, they can learn by gaining experiences with the processes scientists use, but in situations which are relevant and, preferably, simple.

4.8 Children can learn, in groups, that other people do not always see the same phenomena as they do, that their hypotheses may be accepted or rejected by others, and that a "right way" may emerge which will be the best scientific answer at that stage of the group's knowledge. They can also learn that science does not provide absolute answers to or complete explanations of phenomena, and while the facts on which science is based may be constant, conclusions drawn from or explanations of the facts are necessarily tentative.

1 For a definition of "environment" see Section 4.23

4.9 They can learn science from the descriptions and explanations of others - from books, newspapers, scientists in the field, and in many other ways, second hand. They can learn to be critical of second hand experiences, and learn to accept them for what they are. They can learn to make simple checks on the veracity of second hand descriptions, and hence learn the importance of accurate reporting.

## The Science to be Learned

4.10 Children learn the skills of science through their contact with relevant experiences. To handle scientific phenomena they will learn the manipulative and practical skills required to handle the phenomena effectively. This handling of phenomena will provide the information which will have to be processed so that order may be obtained from data gathered. The executive believes it can structure experiences to develop the necessary manipulative and mental skills necessary for adequate investigation of those aspects of the environment relevant and interesting to the child.

4.11 Children can learn that in the ever-growing accumulation of scientific knowledge there is a small number of "big ideas" which act as integrative bonds transcending subject boundaries. They can gain an increasing insight of conservation, equilibrium, order and randomness, energy, change, etc. We believe that experiences can be structured which will promote an increasing understanding of these ideas.

4.12 They can develop models and theories to describe and explain some of the facts they gather. They can understand the important unifying features of models and theories, that such models and explanations are tentative - at best unifying and predictive, at worst confusing and wrong. They can understand some of the more important models and theories that have proved useful scientifically for a long period of time, how these models and theories are still changing, are not rigid or fixed, and no matter how useful, are not accurate descriptions, but rather adequate representations of the real world.

4.13 Children can learn that man is a very special animal - a product of evolution, yet not necessarily the end point of evolution. They can increase their understanding of man as a biological being, with all the possible extensions and limitations of this being. They can understand the extensions of man's physical self (via machines),his mental self (via computers) and (may be) the eventual man-induced biological modification of his genetic inheritance (genetic engineering).

4.14 They can learn that man can modify his environment, that his modification is neither good nor bad until man applies a value judgment to the modification, and that the application of value judgements to such modification is the right of all men. However, to be able to apply value judgments to ensure an improving environment for man requires considerable knowledge of science and it is the duty of each individual to acquire this knowledge.

4.15 Children can learn about themselves, about their bodies and their behaviour. They can learn about the changes possible in themselves due to environmental changes such as a lack or excess of food, alcohol, or drugs. They can learn of the factors which affect their perceptions, the limitations of their senses, and the ways these senses have been extended.

4.16 The executive believes that it can structure learning experiences for children to develop these understandings and promote scientific literacy among the students in Grades 7-10.

4.17 We believe that science provides only one way of looking at the world. That science has links with social science, art, music, and many other areas, is important, and leads to exciting possibilities in schools. For example, motion is not simply a scientific concept, but an artistic, musical, or poetic one depending on your point of view. These are areas that teachers and schools can be encouraged to explore in the development of their own curricula. The extent to which the Project can pursue these avenues will depend very much on priorities, but the Project believes it has a duty to attempt to develop at least some materials which bridge different areas of knowledge.

4.18 Science has a history. It has a long history of development. It has helped shape society and our culture, and will continue to do so. The extent to which these ideas should be introduced as learning experiences for children depends very much on the teacher, and the level of development of the students. The executive believes, however, that aspects of the historical development of scientific thought, the influence science has on history, and the changes in society science may produce in future can be presented, and should form part of the materials we develop.

## The Students

4.19 The executive believes that ASEP is developing materials for children who are in a transitional stage in their development. We believe that the learning materials developed should be structured to facilitate the change from a concrete operations stage, where children have some concepts of their environment and use concrete experiences to test these notions out, to a more formal stage of mental operation, where concrete manipulations are less important. We believe that different children undergo this transition at different rates and at different ages, and that an important factor in assisting the development is the provision of many different kinds of learning experiences. We believe we have to provide learning experiences which facilitate this transition, structured in different ways to provide alternatives from which teachers (or students) can choose.

4.20 We believe that the materials developed by the Project should centre around the child and his development. We believe that in Grades 7-10, facilitating the mental development of the child takes precedence over any specific science understandings and knowledge it may be desirable for a child to have, although we believe we can cater for the intellectual development of the child by providing science experiences which will increase his knowledge and understanding of important areas of science.

4.21 We believe that materials centred around the development of the child utilizing student characteristics like curiosity and excitement, can help children gain a set of cognitive skills, attitudes, and values, which will form a basis for the child's future decision making. We believe values like honesty, idea-sharing, faith in intellect, and positive attitudes towards science and scientists can be encouraged along with the development of scientific understanding.

4.22 We believe that an important part of a child's development in Grades 7-10 is social. We believe that the child is seeking independence and yet seeking to establish his relationship with other people. We believe that science-oriented materials can be developed to further his individual and social development, and to further his understanding that individuals are different in physical, emotional and social ways.

The Fundamental Aim of the Project

4.23 We believe the fundamental aim of the Project is to provide science-linked experiences which help the child to develop intellectually, to grow in his understanding of his environment, and to increase his ability to cope with any new environment as an autonomous, self-directed individual. (We use the word "environment" in this aim, and elsewhere in this paper, in its broadest sense. It includes the internal (biological, psychological) as well as the external (physical, technological, biological, social, etc.) The criteria for selection of any aspect of this total environment for particular study at any given time will centre on its immediacy and relevance to the child's stage of development.)

4.24 We believe that facts, principles, and concepts are not adequate in themselves to produce understanding, nor is any one set of these necessarily better than any other set. The child can best understand or learn to cope with an environment by experiencing many different kinds of environments and by using the processes of science to operate on them. In other words, the science experiences the child has in Grades 7-10 should be designed to make him a more autonomous, self-sufficient, and inquiring individual.

4.25 The executive believes, however, that as the child becomes more autonomous and self-sufficient, conscious emphasis on this aspect of development may decrease during the period of Grades 7-10, but at different rates for students at different stages of development. Paralleling the development of autonomy and self sufficiency, there should be an increasing emphasis on the learning of those elements of science which are considered important as understandings all people need to have.

4.26 We believe that the structuring of certain learning experiences is important, where definite specifiable objectives are the desired outcomes of the experiences. We believe also that certain other learning experiences should be open-ended, where the materials developed can act as a stimulus for activities which cannot be pre-planned, and where the outcomes will depend on the teacher, the students, and the school.

4.27 We believe that there is a place in science education for structured learning experiences which are designed to unfold the essential nature of a particular science discipline, and the importance of this aspect increases over the period Grades 7-10, but we do not propose any formalized study of a discipline in this period. We believe that science in Grades 7-10 should disregard subject boundaries within the field of science; however, it should take due regard of the special strengths of each scientific discipline. Learning experiences will be selected from subject disciplines, not because we think children need to know some physics, some chemistry, or some biology, but rather because the kinds of science learning available within the domains of these sciences are meaningful to the children in their present environment, and at their present stage of development.

## Stages of Development for which Project Materials will be Prepared

4.28 Stage 1. We believe that the first stage of secondary school science should be concerned primarily with working in concrete situations; investigating and developing skills in the processes of science - in describing, classifying, experimenting, and perhaps making models of a large number of carefully selected environmental situations. Explanations of environmental situations should be given only where they arise naturally and spontaneously from the presented situation, and, then, should be consistent with the experience of the children. For example, it could be pointless to explain why water boils. What is important is that the phenomenon can be investigated - i.e. observed, described, and classified. The children may even be able to predict when boiling will occur, but to explain it in terms of vapor pressures or molecular theory seems unnecessary and could be harmful at this stage of development. This first stage, which is dependent on the development of the child, should be very much concerned with real situations, the most important outcomes being evident in the behaviour of the child as he becomes increasingly able to make scientific sense of a new environmental situation presented to him.

4.29 Stage 2. At this stage, more structured experiences can appear. Themes based on scientific ideas and relevant to children can be introduced. The learning of science by secondary methods - i.e. from the experiences of others, becomes increasingly important. The children are more capable of seeing 'order', a structured 'whole', and of grasping more abstract ideas. Some themes that could pervade a sequence of material might be time, measurement, perception, man in his Australian environment, motion, etc. To some extent these materials would be interdependent and to some extent they would stand alone.

4.30 We believe that most students in Grades 7-10 would achieve Stage 1 and proceed to a certain extent into Stage 2.

4.31 Stage 3. A third stage is proposed, which may be appropriate to about 20 per cent of pupils. The materials developed to cater for this stage will require greater facility with abstract thought. The materials would require more sophisticated measurement techniques, and would lead to the understanding of higher level abstract ideas and theoretical models which directly relate to the various disciplines. The materials would not be designed specifically for those students wishing to proceed to further studies, but could well serve as a background for this. They are also to be designed to cater for other students with future interests outside science.

4.32 The executive believes that most of its developmental effort will be in Stages 1 & 2, with the extent of the requirements for Stage 3 materials arising after extensive trial of materials developed for Stages 1 & 2.

4.33 We believe also that different children (and different teachers) become interested in different things. The prediction of the direction of development of an interest is almost impossible. However, when the first signs of an interest in a particular area of learning manifest themselves, it is important that direction be given to help students (and teachers) further this interest. Materials will be developed such that children and teachers can follow up on aspects of interest to them.

## The Role of the Teacher

4.34 The Project believes that the most important variable in the classroom is the teacher. We believe that the development of science materials cannot occur in isolation, and must parallel the education of teachers to use the materials. Indeed the executive sees classroom teachers as having a vital and active role in all aspects of the Project. Not only will they try out materials developed by the Project, they will also suggest materials to be developed. They will try out different structured sequences to establish different pathways, or alternative ways of using the materials that are developed.

4.35 We believe that the amount of imposed structure required by a teacher can be decided by the teacher. We believe that we can provide materials which can serve a dual function of being highly structured for those that require it, yet allowing flexibility for those teachers who wish to develop their own program. We believe such flexibility is essential if the materials developed by the Project are to have wide acceptance in Australian schools.

## The Role of other Project Materials

4.36 We believe that many excellent learning materials have already been developed, both locally and overseas. We believe many of these materials can be integrated with the materials we develop, and can be suggested as alternatives in an instructional sequence.

## Relationship to Primary and Senior Secondary Science

4.37 We believe that the program developed by the Project must take into account the work done by the primary school in promoting the social and intellectual development of each child. We believe that the developers of science courses for senior high school classes must take into account the experience and knowledge gained by children in Grades 7-10 and their stage of mental and social development.

## The Role of Teacher Education

4.38 We believe that the success of the Project will depend as much on the quality and extent of the teacher education program to be provided as it does on the quality of materials that are produced. We believe that the teacher education program can be developed through organizations already existing in the States if they can be expanded to meet the needs of the Project.

We believe that one of the major criteria for determining the success of the Project will be to determine the success of the teacher education program for changing teachers so that they can use the new materials.

## The Role of Evaluation and Services

4.39 We believe that evaluation is an integral part of the development process, and that teachers, students, scientists and parents, as well as Project staff have a role in evaluation.

4.40 We believe that teachers in the field are important resources for ideas and these ideas need to be gathered and disseminated to other teachers. We believe that the Project can provide a resource service to teachers in the field and this service should be expanded as the Project develops.

## 5 CONSIDERATIONS

5.1 A number of special considerations will affect the operation of the Project. Others may have an effect.

5.2 Basically, the resources of time and finance available are considerable. Nonetheless they are limited. There will be a need to attempt to meet many requirements. In practice, it will be necessary to establish a system of priorities. Compromises will be common.

5.3 There will be conflicts between the desire for quality and a consideration of cost. These will occur at both the development and the publication/production stages. Again it will be a case of compromise.

5.4 The executive of ASEP acknowledges the dangers inherent in a situation where one project has a greater allocation of resources than others in related fields. It recognises that ASEP may be seen as overwhelming other legitimate projects whose purposes may not coincide with its own. The executive appreciates, for example, that sponsors of moves towards a "general studies" approach in junior secondary schools may feel that they could not hope to have their case heard if the two projects should appear to be in conflict. We believe that we should co-operate with, and assist, other projects which have compatible aims and appreciate the purposes of other innovative developments in education.

5.5 In particular, ASEP will need to take note of differences, on either an inter - or intra - State basis, in such matters as the degree of autonomy granted to schools, the provision of facilities and the variations, existing or planned, in science education in kindergarten to Grade 6. State requirements will be made known by State Advisory Committees.

## 6 BROAD PLANS

6.1 Some details of Project activities to date are given at Appendix D.

6.2 It is not intended that this paper should detail considerations of the developmental and evaluative tasks of the Project. Before these can be considered in detail it is essential that the rationale be confirmed. Mr Dale and Dr Ramsey will outline some of the possibilities, but we regard these as very tentative at this stage because we believe they are dependent on the extent to which the rationale is found acceptable, and because it is desirable that the area specialists concerned share in the planning of details; this has not been possible so far.

6.3 The submission approved by the Commonwealth and the States provided, in the Development Branch, for the appointment of four Area Specialists covering the fields of biology, physics, chemistry, geology and astronomy. To achieve this coverage specialists in biology, physics, chemistry and the earth sciences have been appointed. The executive is concerned that these appointments may be seen as an indication of a disciplinary approach. As stated previously, we do not propose any formalized study of a discipline in this period.

6.4 The approved submission stemmed from an appreciation of the activities of the Junior Secondary Science Project (JSSP). This submission, for a variety of reasons, suggested that the new Project (now ASEP) should concentrate its early efforts on the development of materials suitable for use in Grade 9 then in Grade 10 before re-examining materials already produced by JSSP for Grades 7-8. The reasons given in the submission for the initial preparation of materials for Grades 9-10 are still valid though lacking the immediacy apparent at the time of submission.

6.5 Practical considerations confirm that once a master plan has been designed, it would be reasonable and feasible to start development at Grade 9 level. In a Project of this nature there will be a need for on-the-job training of staff. In particular, the materials development officers will need training. It is proposed that only half the authorised number will be employed at first, the others to be employed some months later. The training task will thus become feasible.

6.6 It has been estimated that the man-hours required for the developmental work for Grades 9-10 will be several times those required in respect of Grades 7-8. An earlier start on the more time-consuming task appears to be logical in an operation containing parallel activities.

6.7 We recognise that the total plan may be such that it will be necessary, for the sake of those schools already using JSSP materials, to produce an amount of bridging materials. It is intended that effort should be devoted to this activity. The executive does not believe that this approach binds it in any way to adopt the techniques or approaches of JSSP.

6.8 At present, the best estimate possible is that delivery of materials to publishers/manufacturers/producers should start early in 1973, and finish at the end of that year. Materials should become available, commercially, during 1974, so that schools who wish to do so may use the complete range of materials on a large scale in 1975.

6.9 The executive intends that materials should be prepared in accordance with a master plan, and first tried in a small number of readily accessible schools. Evaluation will be concurrent. After revision, the materials will be tried again in a larger sample of schools where evaluation will again be made. The results of evaluation will determine the final form of the materials.

6.10 The executive intends that services to teachers should include training for those to be involved in trial situations, and in this matter we shall look to the State Advisory Committees for assistance, the provision of a resource centre, and the preparation of a model of a teacher training program, appropriate to Project materials, for use in pre- and in-service teacher training activities. The planned operations room at the Project headquarters will be available to visitors who will always be welcomed. It is intended that close liaison with teachers will be established and maintained. We want their ideas. We need their advice about what we are doing.

6.11 Our belief that all students in Grades 7-10 should learn some science spurs us on to an effort to determine what this science should be. We are concerned that our conference, broadly

6.11 (Contd.)

representative as its participants are, is indeed very narrow. Where among us are those who speak, with first hand knowledge, of the needs of the great body of Australians. Let us remember that this assembly comprises highly intelligent, highly educated people, each attesting, through his very presence, to his intense interest in science or education. Those of us who have read "The school that I'd like", edited by Blishen in the Penguin Education Specials series, have been impressed by a portion of the blurb:

> "In all the millions of words that are written annually about education, one viewpoint is invariably absent - that of the child, the client of the school. It is difficult to think of another sphere of social activity in which the opinions of the customer are so persistently overlooked".

Let us note then that in relation to English schooling, a fifteen-year-old boy has written "I am too used to being told what to do", while a girl, of the same age, has recorded that "schools usually have one thing in common - they are institutions of to-day run on the principles of yesterday", and another that she was "tired of hearing that the hope of my country lies in my generation .... if you give me the same indoctrination as a child, how can you expect me to be any different from you?"

6.12 It is the way of our society that authority is seldom exercised before middle age, the most common disease of which is fear of change stemming from our doubts about our ability to cope with it. Let us immunise ourselves against this disease.

6.13 I would like to close with a statement of some personal convictions. I have learned some science. I have helped people to learn science at both the academic and applied levels. I have seen how scientists, how technologists, how technicians work and live. I am full of admiration for them. I believe that in their cases science education has been successful. But they constitute a minute proportion of the total population. On the other hand I have seen how clerks, cooks, storehands, stewards, cooks assistants and labourers work and live. I believe that science education has failed them. They have not been prepared to express informed opinions on conservation, on pollution, on the road toll, on drugs or on fluoridation. Incredibility is my sole reaction when told that there are young women, entering our hospitals for the delivery of their first child, who expect the babe to issue from their navels.

6.14 I believe in science. I believe that science education has a contribution to make. I believe that this Project will make a considerable contribution to science education in Australia by placing it within the grasp and interests of the majority of children. There is no perfect approach. There are millions of patterns possible. We can only do our best. There will be criticism of our efforts. We expect criticism but hope it will be constructive. The degree of our success will hinge on the co-operation of everyone involved in the task.

H. O. HOWARD

9 Jan 70

APPENDIX A

## AUSTRALIAN SCIENCE EDUCATION PROJECT

### Statement by the Hon. N.H. Bowen, Q.C., M.P.,

### Minister for Education and Science

The Commonwealth Minister for Education and Science, Mr Nigel Bowen, today reviewed the progress made in the establishment of an Australian Science Education Project, in which all States and the Commonwealth are participating. This Project is the first national curriculum project to be established in Australia under joint Government sponsorship. It is expected to operate over five years and has a total budget of $1.2 million, of which the Commonwealth will contribute $750,000 and the States $450,000.

Commonwealth participation follows an undertaking given some time ago that the Commonwealth would consider requests for direct support for curriculum development proposals put forward by the States, provided they were sponsored by more than one State.

This Project will provide learning materials suitable for use by students and guidance for teachers in science courses in Grades 7 to 10, that is, the first four grades of secondary school. Provision will be made for individual differences. Any decision to use the materials - or an appropriate selection from them according to local need - will rest with the States, the schools and, finally, the teachers. It is expected, however, that the educational value of the materials will be sufficiently high to ensure their widespread use. Materials will be tried out in schools progressively as they are produced.

A national Committee of Management for the Project has been established. It consists of a nominee of the Commonwealth Minister for Education and Science, a nominee of each State Minister for Education and the Director of the Australian Council for Educational Research. The ACER will be responsible for the detailed management of the Project on behalf of the Committee.

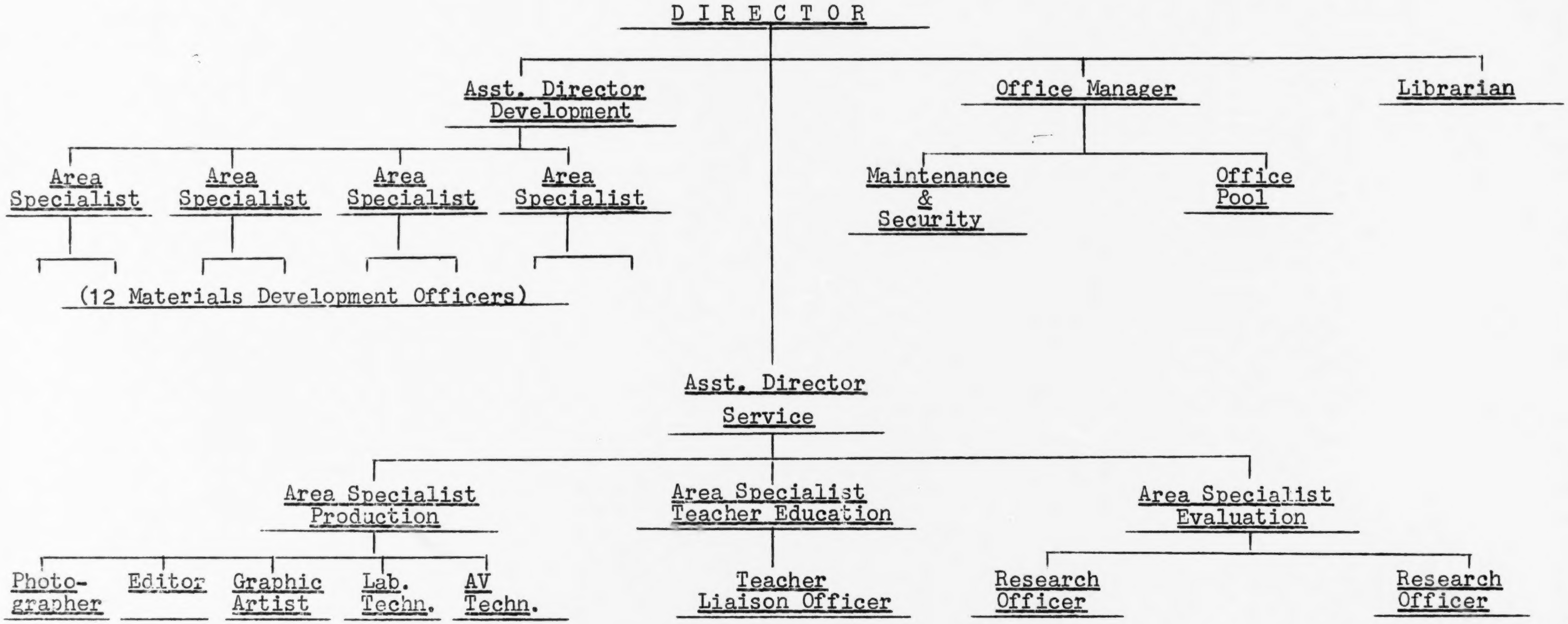
The staff of the Project, which at its peak will have 15 to 20 professional staff members, will be widely representative of Australian educational systems. To ensure adequate advice there will be a Central Advisory Committee at the national level, and State Advisory Committees. These Committees will be broadly based in an attempt to provide the best possible information on which to develop a junior science course appropriate to the 1970's.

Wing Commander H.O. Howard, until recently Staff Officer Ground Training at Headquarters, Support Command, RAAF, has been seconded from the RAAF to become Director of the Project. Wing Commander Howard, originally a science teacher, has had wide experience in syllabus construction and related activities of teaching-aids preparation, and in testing techniques.

A national "ASEP Guidelines Conference" will be held in Melbourne in January, 1970, when representative leaders in the various fields concerned will meet to work out the guidelines for the curriculum materials to be produced by the Project.

APPENDIX B

## AUSTRALIAN SCIENCE EDUCATION PROJECT
## ORGANISATION CHART


D I R E C T O R
Asst. Director Development
Office Manager
Librarian
Area Specialist
Area Specialist
Area Specialist
Area Specialist
Maintenance & Security
Office Pool
(12 Materials Development Officers)
Asst. Director Service
Area Specialist Production
Area Specialist Teacher Education
Area Specialist Evaluation
Photographer
Editor
Graphic Artist
Lab. Techn.
AV Techn.
Teacher Liaison Officer
Research Officer
Research Officer

(N.B. The Area Specialists in the Development Branch should, among them, have special skills in the fields of chemistry, physics, biology, astronomy and earth sciences)

APPENDIX C

## ASEP COMMITTEES

1 The national Committee of Management consists of a representative of the Commonwealth Minister for Education and Science, a representative of each State Minister for Education and the Director of ACER. The Committee has delegated day-to-day management to ACER. This Committee, representing the interests of the contributors, is the employing authority, making decisions on conditions of service for staff. It also makes managerial decisions as it will do when questions of publication/production arise.

2 Two committees have been established to enable the Australian Council for Educational Research to fulfil its management commitment. These are the ACER Internal Advisory Committee, which considers professional matters, and the ACER Internal Financial Committee, which assists the Project in business affairs.

3 A Central Advisory Committee, comprising the six State Advisory Committee conveners, a number of invited specialists, a representative of the Australian Council for Educational Research and the Director of ASEP, is being formed. This committee will function, in an advisory capacity, in major professional areas relating to the nature of science and the goals of science education.

4 In each State the Minister for Education has appointed a convener of a State Advisory Committee to which the Project executive has direct access. These Committees have already given valuable service. It is expected that they will play a major role in stating specific objectives of science education, in drawing the attention of the Project to successful innovations in their own States, and in assisting in trials and evaluation of Project materials.

APPENDIX D

## ASEP OPERATIONS

1 The first appointment to ASEP staff, that of Assistant Director, Development, was made on 1st July, 1969. The Director and Assistant Director, Service, started duty on 1st October, 1969. In addition, the staff now includes five Area Specialists, a Teacher Liaison Officer, a Research Officer, the Office Manager and two full-time and one part-time typistes.

2 Operations so far have centred on administrative and research activities. There was a requirement to furnish a detailed estimate of expenditures for fiscal year 1969-70, a difficult task under the circumstances. The establishment of filing and correspondence systems, the resolution of personnel problems and the investigation of needs for accommodation, furniture, hardware and software have been undertaken. Planning for this Conference has absorbed a considerable amount of effort.

3 Research effort has resulted in the provision of considerable information about nineteen related overseas Projects. A considerable amount of material has been or is being acquired. Study of Australian junior secondary education has provided a great deal of information which will be of value to the Project. Communication has been established with a large number of potential helpers.

4 It is anticipated that the guidelines to be provided by this Conference will furnish the ASEP staff with an adequate basis on which to formulate specific operational plans. While planning proceeds, further staff members will be appointed and trained in their tasks. Arrangements will be made for the re-location of the Project and for the acquisition and installation of facilities.

# IMPLICATIONS FROM OTHER CURRICULUM DEVELOPMENT PROJECTS FOR CURRICULUM DEVELOPMENT IN AUSTRALIA

## INTRODUCTION:

In order to avoid undue repetition of what we have already heard and to leave some room for those who follow after me, I intend to say very little about types of material and research and evaluation beyond what is included in my synopsis.

I am also not going to discuss explicitly implications from Australian curriculum projects. Firstly, you are better aware of these than me and secondly, I believe they mirror the implications to be learned from their parent projects abroad.

Mr Howard's comprehensive and encouraging paper touches on most but not all of the points I shall raise. However, left as it is without the addition of weight and emphasis to the many things he claimed are possible for the project team and the child, the paper does contain contradictions and an impossible clamour of things to be done. It is the task of this Conference to help give these weights and emphases; and this paper is intended as one of the resources for this task.

The more I considered the topic of this paper, the more clearly I realised that the implications that can be drawn depend on a number of subjective factors. Some of these are related to my idiosyncratic self.

For example, I will draw implications about such things as teacher involvement, and the creativity of the project outside itself. I will not draw many implications of a detailed nature about particular types of materials or about organisational aspects other than the role of teachers and consultants, or about how materials should be produced. I am sure that there are many implications about these and other gaps in my response that should be drawn and, I suggest we borrow Dr. Radford's technique of leaving gaps in your notes to be filled from your own quirks and interests.

A second reason why the discussion of implications will be subjective is that it lies very largely in an area of no hard data. This is so, both because much of the data that might exist about curriculum projects does not and because many of the implications are such that no amount of effort could have produced hard data.

I have tried to take account of some existing data and for the rest many of my other comments arise from the contacts I made, late in 1968, when I briefly visited a number of science curriculum projects.

Despite the lack of data and the subjectivity of my or any other individual response to other curriculum projects, I hope we will take very seriously many implications of them. A number of projects now completed or near completion such as ESCP and Harvard Project Physics are clearly distinguishable as second generation science curriculum projects when one compares them with such projects as PSSC and BSSC. I certainly hope that our Project will be as clearly distinguishable as a third generation project in that it takes strength and guidance from what has gone before rather than merely duplicating with Australian dollars what has been done elsewhere with U.S. dollars or with a lack of dollars.

Before I go further to comment on some areas of implication that seem important to me, it might be useful to define a little more clearly the extent of hard data about other projects. The 1968 edition of Dave Lockard's Clearinghouse Report indicates that only 19 out of 68 projects possessed any research evidence of success in achieving their stated objectives. The report makes it abundantly clear that these projects, marking among other things a quite new involvement of scientists with teachers and educators in curriculum development, were unable or unwilling to devote the same kind of effort and enthusiasm to evaluation as to development. On the other hand it can also be seen that one of the marks of a second generation project is the greater emphasis placed on evaluation. I shall return to this later.

The evaluation data from the projects themselves is almost all concerned with what Scriven has called formative evaluation as distinct from summative evaluation. That is, it is concerned with revisions and improvements in development rather than providing information about the effectiveness of finished products. The latter or summative research is of course of greater interest to us or to any other persons making decisions about adopting or not adopting a curriculum.

8 out of 46 science projects in the Report indicate some summative study but only 4 are known to have used a research design in which subjects were randomly assigned to the experimental and control groups.

## Philosophy about science and science curricula

Turning now to a particular type of implication, I will first consider what we might call in Jack Ford's opening words to the Conference, the field of ideas.

Some of the previous curriculum projects have been marked by the fact that, as well as producing materials, they produced a dialogue and debate about science curriculum among the large numbers of people concerned with them. This debate was also continued subsequently with much larger numbers in two ways. Either the dialogue itself was worth reporting, such as Bruner's Process of Education and Towards a Theory of Instruction or the Goals of the Correlation of Elementary Science and Maths by EDC. As the outcome of the dialogue led people like Schwarb (BSCS) or Rogers (Nuffield) or Karplus (SCIS) to formulate a viewpoint sufficiently clearly that it stood by itself as a worthwhile contribution to the aims, and methodology of science education. This creativity outwards does not exist in its entirety apart from the processes of the project. In a philosophy of the Project a rudimentary form is necessary to get the processes started, but in its richest form it has emerged and evolved out of the dynamic of these processes. Furthermore, it is just this philosophy as much as the materials themselves which gives point and purpose to teacher education both preservice and inservice.

Two recent examples of the beginnings of such dialogue in relation to this Project, but unfortunately predating its formal existence were the all too brief discussions that a number of people here had in 1969 with Burkman of ISCS and Romey, now of ESCP, when they visited Australia.

An implication to me concerning this point is that this guidelines Conference should see itself not as the guidelines conference which contains and concerns all this dialogue, but as the first of a series of such conferences involving a variety of different groups of people (always with the classroom teacher well to the fore).

I believe too, that if we are to be a third generation project we cannot hope to plan and produce all this dialogue from within our own shores. Decisions about setting aside adequate budget to at least ensure the conditions of this dialogue are ones which this conference should I believe make.

What sort of issues should the dialgue concern itself with. Again having guidance from the other projects they were concerned with the questions of what sort of science education for whom and how.

These are properly part of the dialogue which we should begin here.

The first generation projects often made decisions about what sort of science which can clearly be seen to favour the individual nature of the scientific disciplihes and within these emphasise more or less strongly the content or the processes. There is also evident a general trend which has placed an enhanced emphasis on building an understanding of the processes and patterns of thought whereby science or a particular science proceeds.

This trend has been so common among previous projects that it may also be unquestioned that this project will follow suit. However, the actual materials that have been produced, the way they have been used by teachers in project after project, and the real expectations of those who are the next in line as teachers in the educational experience of the child belie this apparent agreement in aims and emphasis.

This project like its predecessors must face, (and because of their failures must face more seriously) the questions of whether or not we too believe that it and its materials should primarily be directed to developing attitudes such as

1. 'a healthy scepticism regarding accepted knowledge and a willingness to abandon ideas which are demonstrably erroneous'

or 2. 'an humility interest in the realisation that our understanding is never complete'.

or again, do we agree that 'most of the efforts of the science teacher should be devoted to teaching the methodologies of science and accordingly that the children will only acquire a small example of scientific knowledge of the factual or content kind'

or again, do we see any reason, 'why one child's small example of scientific knowledge should be the same as anothers'.

or again, do we agree 'that of central impartance to our science courses is the development in the child of the use of models in science'.

## Horizontal implications

Associated with this the answers given to these sorts of questions in other projects, it is possible, I believe, to see a trend at the level of our concern in science education to a greater degree of integration of science disciplines and to a greater out-reach from science to other activities with the school and the total educational experience of the pupil. Examples of this are to be found in some of the newer Nuffield projects, the Intermediate Science Curriculum Project in Florida, and the Scottish courses for the third and fourth years of their course for the general school population.

While many examples can be found of projects which have restricted themselves to the boundaries of a traditional discipline or to a narrow definition of science they can often be seen as being predetermined in this restriction because they have been aimed at selective or special groupings of secondary pupils. They have not, in a word, had to concern themselves with the problems of motivation in the secondary pupil, or with the problems associated with the trends to universal secondary education as an end in itself which, as Hon. Mr Bowen and Dr Radford pointed out, are now complete in the Australian scene. Another manifestation of this emphasis can be seen in those projects abroad which are trying to concern themselves with science and technology or the interaction of science with society.

If the animated discussion which began yesterday on the primary of social relevance in science courses should happen to continue to develop, and if we should agree that this is a keystone of our efforts in this project, then it would be an example of the sort of creative outreach of ideas that mark good projects. This particular idea would certainly also stamp us as a third generation project.

John Mayfield, last month in Melbourne, reflecting on the same topic as mine this morning, expressed the belief that he saw as an implication of trends in other projects that there is emerging an interest in the sociology of science itself which in my opinion, may be a more appropriate component of science courses than an historical one if a choice has to be made.

If this project is to move in either of these last two directions, can we do it from within the traditional ranks of science itself? Or will we need to take steps very soon to engage in dialogue with those concerned with curriculum projects in mathematics, the social sciences and the humanities.

## Vertical implications

These implications I have just discussed are largely concerned with horizontal outreach from science, but there is also a sign in a number of projects that science education does not begin at grade 11 or 7 but very much earlier in the education of the child.

A growing number of curriculum projects in science education are concerned with the primary or elementary stages of the child's education and already in Australia some of these have started. What regard should this project have for the likely outcomes of these?

All these horizontal and vertical implications raise parallel questions about the types of material and no doubt they will be considered more fully tomorrow.

## Implications about the nature of curriculum

Out of the spate of curriculum activity has come a fruitful debate about what a curriculum is. In particular what is the relation in a project between its curriculum and the material and learning experiences provided by projects?

Although there is by no means agreement as to the nature of the relation there have been a number of attempts which certainly define things more clearly.

My interest in this has been roused in a number of ways. One of these and an important one is associated with the problem of evaluation of a curriculum and its materials.

Another, and the one of relevance here, is the observation that some of the recent projects seem to have stifled further initiative about teaching and others have encouraged it. Among the former are PSSC and among the latter are CHEM STUDY and BSCS.

Now one reason that PSSC is in the former category is its excellence and the great difficulty of producing better material than it has.

However, I believe there is another reason and this is associated with whether curriculum and materials and learning experiences are closely identified or distinguished.

Johnson has recently made a helpful contribution defining a curriculum quite differently from its materials and learning experiences. For him the curriculum implies intent concerning instruction - it is a structured set of intended learning outcomes. The materials and learning experiences are one or more ways whereby the child or the teacher - child relation seeks to obtain these outcomes for the curriculum.

If such a stance is taken the project will produce both a curriculum (this may be an extensive and exemplary statement) and sets of materials. At least two parallel sets for some children and purposes would be necessary at least for parts of the overall learning period.

In this way, I believe, it will enhance the chance of this project to be an encouragement of initiative than a stultifier.

Implications concerning teachers in the development of a projec

I think without exception, unless it be Scotland where rather special conditions exist, all the curriculum projects I visited unhesitatingly said that they had failed to involve enough class room teachers in the process of development. This was true whether they were heavily centralised projects with a small writing staff, or were ones which had involved scores of teachers in some way. Repeatedly I was told of the benefits that accrued to these teachers who were, in fact, involved in stages of the creation of the materials - benefits which were not gained when it was merely a case of being schooled in the use of a packaged deal of instructional material. There is even hard data on this point from Walberg's studies for Harvard Project Physics.

There are many lessons to be learnt here. We need to increase the involvement of teachers in the processes of the project by writing conferences, during trials and revision and by establishing machinery to help teachers in local areas to receive, adapt and use the materials when produced.

Elsewhere these lessons from earlier projects are being learned in various ways. One conception of the regional labs in the States was for this very purpose. The Science Equipment Centre in Edinburgh is another splendid and more successful example as are the regional science centres in England.

Both the Project centrally and the State Advisory Committees locally need to give very careful consideration to these questions and backed with an adequate slice of the budget. establish suitable co-operative machinery to involve the maximum number of teachers.

There is, however, another set of implications to draw from projects which relate to the class room teachers. Implicit in many projects there are, I believe, assumptions about the teacher resources available. One group of projects assume that these resources are able and in adequate supply. Materials are produced accordingly, which assume that the learning outcomes are primarily achieved by some sort of teacher-pupil interaction. This is the case in Scotland and in the original Nuffield project for the grammar school child in England.

The other group essentially assume that the teacher resources are inadequate and the learning outcomes will at least to some extent be achieved from the interaction of the pupils with the materials. In this category I place PSSC, I.S.C.S. and J.S.S.P.

Which of these assumptions will influence the present project? At the moment there is little doubt that teacher resources are very inadequate throughout Australia at the lower secondary levels. Will this pertain when the materials from this project are available and in general use?

## Implications regarding the use of Consultants and Experts

As well as involving large number of teachers in the project there is another group who need to be considered. Most other projects report that they have not been able to involve, in a full time capacity, a number of people who had valuable contributions to make. Looking round Australia with much more limited resources of experience to draw upon, I see that this project is no exception and been no more successful. The Nuffield projects and most of the American ones have solved this problem by a variety of flexible arrangements which have included consultancy for special purposes, subcontracting out, and short term and part time involvement of experts.

If this has been necessary in countries with many more personnel resources than Australia it seems that this project should also adopt such flexibility to maximise the contributions that can be made to it over the next five years.

## Science education in relation to education itself

One other implication that I noted in a number of projects abroad is their current concern that the science curriculum project should be consonant with the directions of education in general.
Firstly, science justifies itself in a total school programme because it contributes things to the general education of the child which it does better than other subject areas or approaches
If it is to do this it can only do so by being true to its own nature.
One aspect of this nature is that Science itself is a social process.
Accordingly, it can make a real contribution to the development of the child as a social being. (Note this is not to be confused

with the question of the social relevance or social responsibility of science referred to above).

Projects particularly concerned about this contribution of science edcuation are ESS, Nuffield and the new stages of ESCP.

Secondly, there is an interest in Scotland, in England and in the USA in projects like ESCP that the curriculum projects do not omit in their emphasis the recognition in these countries that education must contain compensatory features.

That is, the recognition there that educational opportunity is not achieved by simply providing materials and other extra-school experiences (which may even take account of individual differences in learning rates). Compensatory education means that beyond these the curriculum project takes seriously the differential extra-school environment and experience of the children.

At the moment in Australia we have clear evidence of all sorts of inequalities in our education scene. It also seems to be a consensus of opinion that we have not yet reached a point where compensatory features have been accepted as part of our education. Rather, Australia understands by equality of educational opportunity, the provision of equal minimal resources within the school. None the less by 1975 the voices being raised in political and educational arenas for us to join Britain and USA in accepting compensation may well have had some success and this project may well be able to accelerate this acceptance if we wish it.

P. J. Fensham
19/1/70

# ASEP GUIDELINES CONFERENCE

## COMMENTARY BY DR R.S. VICKERY ON PAPERS DELIVERED BY MR H.O. HOWARD AND PROFESSOR P.J. FENSHAM ON MONDAY, JANUARY 19

I think we would all as a group be much in agreement with something we have heard from each speaker who has held the floor to this point: that this is a very significant breakthrough in Australian science education. It represents by any standards, and certainly by standards that we have known in Australia before, a very massive outlay of resources and materials to enable us to do something most significant in science education.

I suppose it is reasonable that the success or otherwise of our Project will be evaluated 10 years from now by those who look back on us and judge us by the degree to which it has influenced science teaching across Australia. We might well come up with some sort of operational definition for the success of this Project and frame it in terms of first, the extent to which the ASEP materials have been adopted or have influenced the materials that are adopted across Australia, and second, the extent to which the Project or its materials are influential, directly or indirectly, in changing the learning experience of students in science in our schools consistent with the objectives we establish for this Project. If 10 years from now scientific education in secondary schools across Australia has undergone very little by way of change that we can attribute to the impact of this Project, I would feel and I think that you would support this view, that we probably squandered what is likely a one-shot opportunity to have a very significant influence.

In trying to decide which of the many comments that the two speakers have raised I might bring before you and try to elaborate, I had some difficulty as you will understand but have brought out several matters which I think are rather crucial, probably reflecting my own idiosyncracies in science curriculum development but which I would like to raise for you.

First I would concur with the point of view expressed by Professor Fensham that the history of other curriculum efforts suggests that while the broad goals of the undertaking can and indeed must precede development, the detailed fine-grained objectives of any Project emerge from the on-going development of the materials themselves. I believe we should see our role in the development of this Project as one of assisting the Project to clarify its broad objective and not one of defining fine-grained content or the fine-grained approach of this Project. I think it is quite unrealistic for us as a group to consider that in a week we could think through in detail all the implications of any fine-grained objectives that we may set up and I think we would run a risk of locking the Project into an untenable position of fine-grained objectives which could not be realized and I think that this is a danger that we should avoid at all costs.

Secondly I see some conflict and some need to compromise between two positions which I read into your report Mr Howard. On the one hand I interpret this rationale to imply that the materials will be produced largely as a series of unrelated topics, each topic largely independent of those that precede or follow it. In this way the schools and teachers are offered a sort of curriculum smorgasbord from which they select according to their culinary tastes or their dietary restrictions, the sort of programme that they feel most appropriate for their students in their school with the teaching skills that they have to offer. This position appears to me to be in conflict with the position which I also interpret from the rationale that you have put forward.

The rationale implies that there are certain powerful scientific concepts and certain scientific processes which should be identified and which should be part of the repertoire of skills and information that students take away from a science programme at this level. The development of scientific concepts and scientific processes is I think by definition hierarchical. Each one of these, for example the development of a particular skill, is dependent on the student's prior acquisition of certain previous skills. To elaborate very briefly on one of the powerful themes which was mentioned in the earlier paper "Energy and its Transformation", no matter which route the Project decides to tackle the development of energy and its conservation, it would be necessary, I think, to build into this concept, a sequence of ideas that probably involved some or all of momentum, work, electrical energy, heat energy, force, motion, distance, time and mass. As I see the development of powerful concepts and powerful processes, these will involve sequences of highly-related, highly-structured materials in which what the student learns at one stage becomes the basis for his learning at the next. I see some resolution of these two positions of conflict will be necessary at some stage in the Project material.

Thirdly, I feel very strongly in support of a point that Professor Fensham raised towards the end of his paper this morning, namely that we should make every attempt in this Project to involve the best people that are available in Australia, in the development of the materials. I think we should look at the structure of the Project, the structure of the preparational materials, so that we ensure that we optimize the contribution that interested and able and competent people may have to make.

Fourthly, I'm rather unsure of the intended role of the existing JSSP materials in ASEP and this is clearly a matter that needs most careful consideration. The JSSP materials represent the product of a most substantial investment of time, finance and expertise and they form the base from which this Project, the ASEP was launched. To the extent that the existing JSSP materials can be incorporated in ASEP, then we are that much further down the road. We have that much of our development done, we have that much of our finance available for meeting other objectives. There are I think, other alternatives, which we should probably also consider.

Professor Fensham has referred to the substantial effort in curriculum development that is going on and has gone on in the past decade overseas. Projects such as Time, Space and Matter, I.P.S., The Earth Science Curriculum Project, Intermediate Science Curriculum Study, Nuffield Science, these are probably the most significant Projects at this level, currently available. These Projects also represent a bank of available resource material, which we should consider, I think, as possible alternatives as a starting point for the ASEP Project. Private conversations with Romey from ESCP, and with Burkman from ISCS have led me to believe that these Projects and probably any of the other major Projects would listen most sympathetically to a proposition to adapt and modify all or part of their materials for inclusion in our ASEP Project. However, I concur with the reservations that other speakers have expressed earlier of accepting any ready-made objectives of any existing Project materials. It seems to me that before we decide what materials we should be using as starting points, what assumptions we are making about these, that we must first clarify the objectives of this Project. The adoption of existing materials, whether JSSP or otherwise should be considered in terms of the degree to which these objectives meet the objectives that are established for this Project. What are our objectives in ASEP? To what extent do any curriculum materials match these objectives? This seems to me to be the only criterion that we should use as a basis for accepting other materials, and I feel quite strongly that neither financial considerations nor temporal expedience should be or is a sufficient basis for the acceptance of existing materials from any source. I feel that we must first establish objectives and identify the sorts of instructional procedures that we think appropriate to reach these objectives, and only when we know what we are trying to do are we in a position to say whether or not a particular set of materials are appropriate to the aims we have established.

In establishing the objectives and the methodology for this Project, we will need to raise and resolve many issues. Most of these have been raised from the floor at various times already. I would like to have the time to go through some of these at depth, and present some sort of a balanced picture from my viewpoint on them, but time does not allow, even though I would like to do this. In establishing the objectives and instructional strategies of our Project, I think we will need to resolve many issues. These include such questions as: "Should the curriculum be concerned with the superficial survey of many of the areas of science or should it be concerned with the development of a few powerful ideas such as 'Energy and its Transformation', 'Conservation', or some of the others that have been earlier identified?" Should the curriculum be hierarchical in development, pursuing a story line in which each learning experience builds upon those which precede it, or should it be composed of relatively independent units which will allow individual schools and individual teachers the maximum flexibility of choice from among them? Should the curriculum be inductive in nature, involving interpretation of laboratory experience or should it be essentially expository, so that the level of knowledge of this generation can be imparted to the next with the maximum efficiency? Should the curriculum be equally concerned with the information of science, the so-called product dimension of science and the skills by which this information is obtained, organized, interpreted and communicated, the so-called processes of science?

These are just a few of the issues, I think, which we as a group need to deliberate upon to provide guidelines to assist the Project in establishing its broad objectives. I believe that this is probably our first and most important task as a group.

As a somewhat parenthetic corollary, I believe that there are rather serious implications in the present plan to produce Grade 9 and Grade 10 materials immediately. Such materials can only be compatible with and hence continuous with existing Grades 7 and 8 materials if they are based on somewhat highly related objectives. To prepare 9 and 10 first would seem to me to imply the pre-acceptance of 7 and 8 and I am not sure that we are in a position to do that at this point. For my own part, I have not been able to ascertain the position of the existing Grades 7 and 8 materials on many of the issues that I have raised or other issues that could be raised. I believe that the decisions to incorporate any curriculum materials into ASEP, whether they come from Time, Space and Matter, ISCS or any other source is premature until the objectives of the Project have jelled. It would appear a major error in strategy to constrain the expanded Project by the premature acceptance of any prior existing materials.

Over the last five or six weeks, I have been involved in a series of meetings with a group just such as this, composed of people who are representatives of the same sorts of interests as we have here, perhaps being more representative of teachers in schools than our particular gathering and this group, as a State Advisory Committee in my home State, has been looking at the sort of objectives that they would like to see in a science programme in lower secondary schools. They were able to start with at least one common factor, which was a very large measure of disenchantment with what exists at the moment in my own State, and so they were able to view the objectives of curriculum development without any consideration at all to what exists at the moment, because they were able to assume, and I think fairly gaily, that most of what exists now is ripe for change. I have brought with me a copy of a Position Paper that represents the viewpoint of this particular group of people on what they would like to see as the objectives met by a curriculum project at this level. I think the thing that strikes me most in listening to the speakers that we have had to this point, and knowing the content of the paper, is the degree of commonality that exists between the various groups. Although there is a different sort of jargon used and a different organization of that jargon within the paper, there is in essence very little difference between the positions that have been taken. Probably the only major difference is the emphasis which this other group has placed on the systematic and hierarchical development of process and concept as distinct from the somewhat unrelated, unstructured unit approach. I will make these materials available to you, not because they represent anything other than a viewpoint of one group of people just such as yourselves, but they are relevant to the sorts of things that will be being discussed over the next two or three days, and may provide some useful information.

Let me recapitulate very briefly by saying I found it difficult to come up with a significant commentary on these two very thoroughly prepared papers. The points of view that I have raised may not be the ones which you consider to be the most significant. I have tried to keep my time to the quarter of an hour allotted, so that those of you who wish may have the opportunity to raise other and in your view more significant points pertaining to the paper that we have heard last. Thank you.

# WESTERN AUSTRALIAN STATE ADVISORY COMMITTEE A.S.E.P.
# POSITION PAPER JANUARY 1970

(COPY)

## PURPOSES OF THE PROJECT

1. The committee considers that the primary purpose of the ASEP Project should be to develop instructional materials in science for use by teachers and pupils in grades 7 - 10 in Australian schools.

2. The project staff should be concerned with the evaluation of current curricula, the construction of evaluative instruments, teacher education and special resource materials only to the extent necessary to achieve the primary purpose.

3. While the project should be concerned with the development of a four year sequence from grade 7 to grade 10, it is crucial that the structure of the programme should allow successful adoption in states with either a 6 - 6 or a 7 - 5 primary - secondary organisation.

Of the various options discussed by this committee, the most appropriate structure appears to be a programme which allows first year high school students to enter at either grade 7 or grade 8 of the programme. This implies that the essential entry behaviours into grade 8 are clearly identified and are such that either they are a reasonable expectation from a grade 7 primary course or can be met by a short course undertaken at the beginning of grade 8.

The committee holds the view that a structure in which a three year course can be obtained by judicious selection from a four year course is a less desirable alternative. Such a design appears to inhibit the opportunity to develop a curriculum in which there is an hierarchical and systematic development of concepts and processes.

The committee further considers that a structure in which some students exit after three years into grade 11 and 12 science programmes, while others exit after four years is also unsatisfactory. If student achievement after three years is at a level appropriate to enter grade 11 and 12 science, it is difficult to justify a fourth year for other students.

## ROLE OF EXISTING J.S.S.P. MATERIALS

1. This committee feels strongly that the establishment of acceptable objectives and instructional procedures should precede any attempt to evaluate the suitability or otherwise of the existing J.S.S.P. grade 7 and 8 materials. The expanded project has both broader objectives and far greater resources than the initial project. The total curriculum should be rethought on the basis of its Australia-wide objectives. It would appear to be a major error of strategy to constrain the expanded project by the uncritical acceptance of the existing materials.

2. The four year programme (see Appendix I) must take cognizance of:

(i) The competencies of students entering the programme from the various primary science curricula in the participant states,

(ii) The organisational structure (e.g. number of periods per week) within which science instruction must operate in each state,

(iii) The objectives of science teaching acceptable to the participant states,

(iv) The methodological procedures indentified to optimise the achievement of these objectives,

(v) The format of the instructional materials,

(vi) The articulation between the course and

(a) matriculation science programmes,
(b) non-matriculation science programmes, and
(c) the needs of terminal students.

(vii) The resources currently available frommajor curriculum projects - Wyndham Science, J.S.S.P., I.P.S., Nuffield, I.S.C.S., E.S.C.P., Time, Space and Matter.

3. The comments of this committee with respect to the existing J.S.S.P. materials are included in Appendix II.

## OBJECTIVES OF SCIENCE TEACHING

At a global level, the general aim of science teaching is to develop attitudes, interests, knowledge, understandings and skills which will enable students to develop an appreciation of themselves and their changing environment. This committee considered specific aims under four headings.

1. Knowledge and understanding.
2. Cognitive skills.
3. Attitudes and interests.
4. Psycho-motor skills.

### 1. Knowledge and understanding.

The curriculum should develop in the student a knowledge of and an ability to apply, the factual content, the conventions, the procedures, the laws and the theories of the scientific disciplines. This committee considers that an integrated view embodying aspects of major disciplines should be presented. The choice of specific content areas should be determined by the extent to which the material is illustrative of the organizational themes underlying all disciplines. The eleven ideas listed do not imply eleven separate storylines nor should these points lead to fragmentation of the course because each point is common to a number of the traditional disciplines of science. Essentially the eleven points express the major concepts about energy and its transformations, fundamental particles, living processes (or organisation) and change.

### The Powerful Ideas of Science

(i) All matter is composed of fundamental particles.

(ii) Fundamental particles can interact, the bases of all interaction being electronic, gravitational or nuclear.

(iii) Interactions tend towards equilibrium in which potential energy is minimum and randomness is maximum. The spontaneity of change does not reflect the rate.

(iv) In the process of obtaining equilibrium mass transformations, mass/energy transformations, or energy transformations can occur. The sum of mass and energy is constant.

(v) One form of energy is motion of matter units. This motion is responsible for heat, temperature and phase.

(vi) Aggregates of particles can be classified into hierarchies of organisational levels. The characteristics of aggregates can be described on a statistical basis.

(vii) Aggregates of particles classified as living, share basic organisational structure and basic interparticle interactions.

(viii) There is a great diversity of living organisms. Characteristics of the parent/s are inherited by the offspring.

(ix) Evolution of living organisms arises from mutation and natural selection.

(x) All matter exists in space and time. Matter is subject to change with time. This change occurs at various rates and in various patterns.

(xi) The scale of time and distance in the universe is enormous.

2. Cognitive Skills.

This committee considers that the skills by which information is obtained, organized, interpreted and communicated are of at least equal importance to the information itself. Cognitive skills of comprehension, application, analysis, synthesis and evaluation should be systematically developed in any curriculum. Science is an organised method of human enquiry. Students should be trained in the special process skills of scientific enquiry. Such process skills should not be taught in isolation but should be systematically developed along with the content of the programme. The list of processes identified by this committee does not imply fragmentation nor does it imply a teaching sequence. The sequence of development should parallel the student's learning sequence which is not necessarily the same as the way an adult would tackle a problem.

The Processes of Scientific Enquiry

(i) Gathering Data

- (a) Making observations using all senses
- (b) Distinguishing observations from inferences
- (c) Making quantitative observations

(ii) Organising Data

- (a) Classifying and tabulating data and events
- (b) Identifying patterns and irregularities in data
- (c) Making predictions based upon trends observable in data
- (d) Applying the systems approach to isolating a problem

(iii) Communicating Data

- (a) Presenting information by means of tables, graphs and diagrams
- (b) Presenting information by means of concise logical written or verbal reports

(iv) Designing Experiments

- (a) Recognising and stating a problem
- (b) Defining operationally
- (c) Controlling variables
- (d) Formulating an hypothesis
- (e) Planning and pursuing an experiment

(v) Interpreting Data

- (a) Interpreting data from tables, graphs and other reports
- (b) Drawing conclusions
- (c) Stating and using mathematical relationships between variables
- (d) Formulating models

3. Attitudes and Interests.

Much of the factual content of a particular programme may prove irrelevant to the future activities of students and much is readily forgotten. This committee supports the view point that the attitudes towards and interest in pursuing science which arise from a programme are of great importance. We believe that the programme should seek to develop in a systematic way:

- (i) An attitude of enquiry by encouraging and developing his natural curiosity and interests, and a readiness to pursue these interests.

(ii) A confidence in, and desire to use scientific procedures for seeking knowledge.

(iii) An awareness of the limitations of scientific method in matters concerning value judgements.

(iv) A tolerance towards the opinions of others.

(v) A willingness to suspend judgement, consider new evidence and change o pinions in the light of new data.

(vi) An appreciation of the impact of science on the changing environment.

(vii) An appreciation of the role of science in the conservation of natural resources.

4. Psycho-motor Skills.

A science curriculum should identify and systematically develop psycho-motor skills.

(i) Using instruments to extend the range and precision of the senses.

(ii) Manipulating, assembling and fabricating scientific equipment.

(iii) Using instruments to quantify observations.

## INSTRUCTIONAL PROCEDURES

This committee considers a curriculum most likely to achieve these objectives when it embodies instructional procedures with the following characteristics.

1. The curriculum should be a balance between the inductive and the expository dimensions of teaching. Students should participate in meaningful enquiry based on laboratory and field experience.

2. The curriculum should be structured around the major concepts of science. There should be a sequential development of a few powerful ideas rather than a detailed survey of the information of science.

3. The curriculum should incorporate the structured development of the processes of scientific enquiry. Students should learn in a systematic way the skills of obtaining, organizing, interpreting and communicating scientific information of designing and conducting experiments.

4. The curriculum should cater for differences in entry skills and learning rates of children of this age range. The committee feels that there is a place for both a multi-track approach and accelerated progress in providing for individual differences. The committee opposes organizational constraints which inhibit the natural progression of the able child. The committee also expresses reservations as to whether a single set of materials, even with acceleration, can meet the needs of the full range of ability.

5. The curriculum should foster the systematic development of independent study habits and enquiry skills. As the student builds an increasing store of information and process skills, the materials should tend from highly - directive toward open-ended enquiry.

6. The curriculum through its instructional materials should capture student interest and carry a high level of intrinsic motivation. This further implies that the demands upon the child be related closely to the child's experience and to his level of cognitive development.

7. The development of process skills and powerful ideas should be spiral so that the student applies the same skills and ideas in a number of different contexts, thus favouring retention and transfer into novel situations.

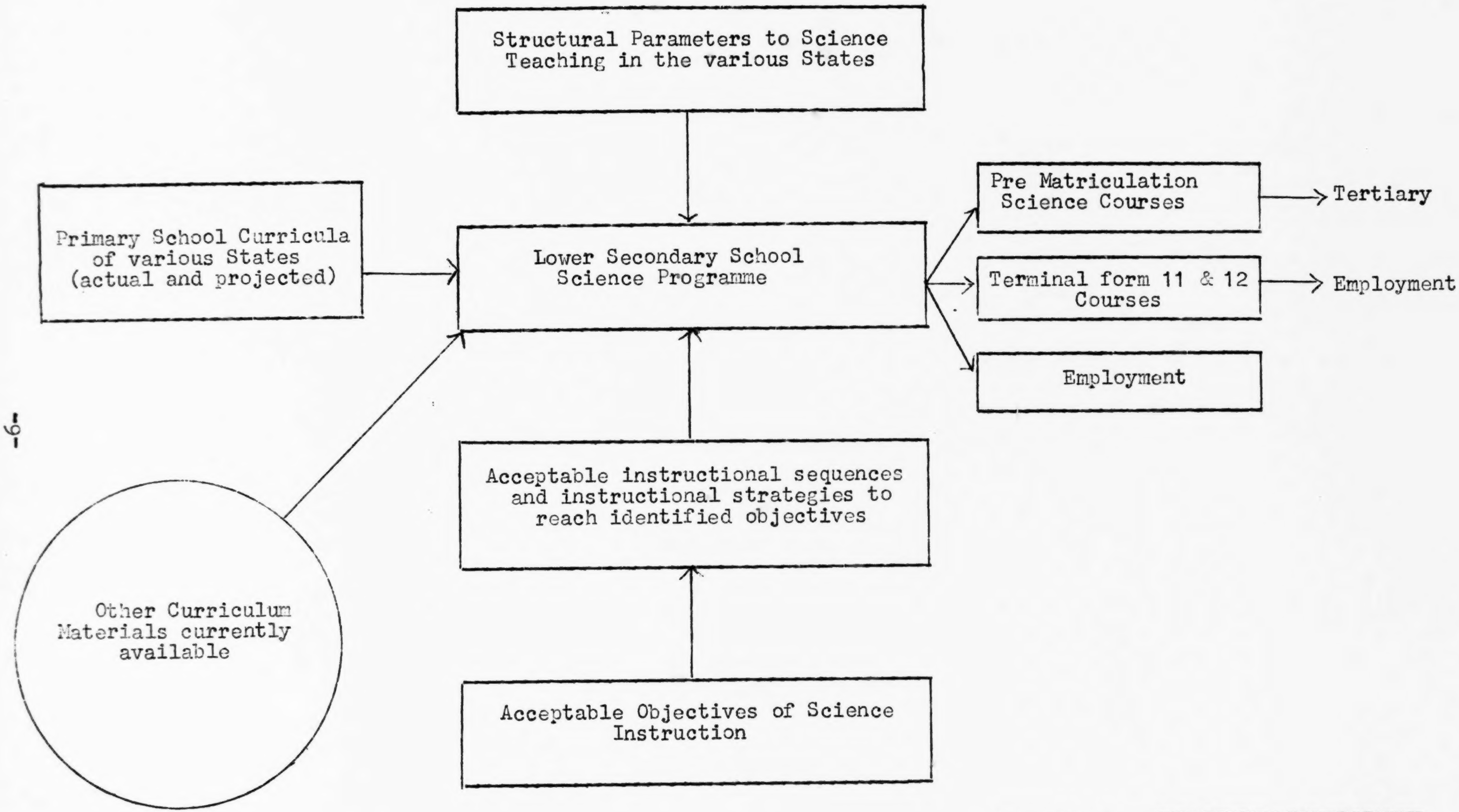
8. The committee believes that sound instruction is hierarchical with each unit building on the outcomes of preceding units.

9. The curriculum should take into consideration the curricula in other subject areas, particularly mathematics, reading and written expression so that the skills and methods required at various levels are appropriate. In some instances it may be necessary to include direct instruction in mathematical (or other) skills such as graphing, averaging and scientific notation.

10. The emphasis should be on the development of scientific concepts and processes. However, opportunities should be created to raise, without moralising, the moral and social implications of science.

11. The curriculum should be compatible with the conditions pertaining in Australian Schools, particularly with respect to the qualifications and experience of teachers, the provision of laboratories and equipment and class sizes.

12. The curriculum should incorporate systematic and progressive (cumulative) assessment of student achievement across the widest range of objectives.


Structural Parameters to Science Teaching in the various States
Primary School Curricula of various States (actual and projected)
Lower Secondary School Science Programme
Pre Matriculation Science Courses
Tertiary
Terminal form 11 & 12 Courses
Employment
Employment
Other Curriculum Materials currently available
Acceptable instructional sequences and instructional strategies to reach identified objectives
Acceptable Objectives of Science Instruction

Appendix 1: CURRICULUM DEVELOPMENT SEQUENCE

Appendix II

## EVALUATION OF EXISTING J.S.S.P. MATERIALS

The following comments were endorsed by this Committee after examination of the J.S.S.P. materials.

1. The committee found it difficult to determine the position which had been adopted by J.S.S.P. on many of the issues discussed in the body of this paper.

2. The materials have made a substantial step forward in providing for individualized instruction by using printed materials rather than the teacher as the primary source of information. Individual students are thus able to proceed at their own pace in each unit.

3. Committee members did not consider the procedure of inhibiting the forward progress of individual students by forcing a lock step completion of each unit appropriate.

   (i) It is assumed that any course represents a systematic and logical development of concepts and skills. If a particular concept or skill is necessary to this development it is included in the sequence. By definition the appropriate activity for a student to undertake at any point is the next activity in this sequential development; rather than some optional side issue.

   (ii) The use of research activities in J.S.S.P. would appear to act as an artificial contrivance to hold students together in the sequence. In the early grades, the students have neither the mastery of sufficient information nor the mastery of appropriate enquiry skills. As a consequence many research activities are trivial or over directive.

4. Most cards involve the students in the actual handling of materials. However, the committee members could find little to indicate that this laboratory emphasis is directed towards the systematic development of identified enquiry skills. We consider that the systematic development of process skills should receive emphasis comparable with that placed on the development of the knowledge and understanding of scientific facts, principles and laws.

5. There is seemingly little evidence of hierarchical development of skills and concepts.

6. Like the existing Western Australian Science A syllabus, the JSSP materials tend to present a series of unrelated topics. A superficial study of JSSP materials does not reveal that the content is structured around the powerful ideas of science.

7. In comparison with E.S.C.P., I.S.C.S. or Time Space Matter, the materials are drab and unappealing. The literary style is rather formal and the use of art work to enliven the appearance is minimal.

8. The advantages of a card based system are not at once evident. The disadvantages of logistics of distribution, lack of durability, expense and inhibition of back reference seem to outweigh the possible advantages of flexibility and ease of updating parts of the materials.

9. Poor reading ability severely handicaps some children in this type of instruction. For this group of students, printed instructions should be associated with pictorial instructions.

# ASEP CONFERENCE

## SYNDICATE SESSION - MONDAY

Whereas many major matters have already been raised, it is not appropriate to discuss all of them at this stage of the conference. There will be opportunities at more appropriate times to consider those major problem areas omitted below.

The outcome of this session should be a firm statement of the fundamental aim of the Project. To this end it appears appropriate to record consensi and significant minority opinions that arise from a discussion of the stated rationale, paying due regard to the implicit assumptions concerning the goals of science education contained therein.

It would assist the organization of the products of the discussion if each syndicate uses the heading set out below for both the discussion and the syndicate reports. Additional headings considered to be of equal or greater importance should be added.

1.1 The importance attached to the personal development of the pupils

1.2 The importance of the pupil's immediate environment and interests

1.3 The importance of the future needs of the individual in society

MONDAY (Continued)

1.4 The importance of the great body of scientific knowledge and processes

1.5 The importance of the separate scientific disciplines

1.6 The importance of the demands of higher secondary and tertiary education

2. In the light of the answers given above what amendments, additions or qualifications should be made in respect of the stated fundamental aim of the Project?

MW 19-1-70

Paper 1

1. Is the last sentence of paragraph 4 of the synopsis an adequate summary of the aims of ASEP?

2. If not what should replace it?

Paper 2

1. Should teachers be involved?
2. How should they be involved?
3. What meanings can be given to the term 'integration' in this context?
4. What aspects of integration are relevant to ASEP?
5. To what extent should there be choice of materials for student or school?

Discussion on Sunday has suggested that, as a result of this conference, there will be a common syllabus throughout Australia. Is this so?

Does the last sentence of paragraph 4 of the synopsis of "The Purposes of ASEP" imply that we are not going to adopt a "disciplines" approach?

To what extent should ASEP follow themes of the "powerful ideas of science" e.g. particulate nature of matter, equilibrium? and/or the processes of scientific enquiry?

Should the prime aim of ASEP be to develop a science course in its own right, or should it be to meet the requirements of the various States?

MONDAY

|  | No.1 Syndicate | No.3 Syndicate | No.4 Syndicate |
|---|---|---|---|
| 1.1 | See 1.3 | What do we believe to be the rôle of the personal development of the pupils in the education of children in grades 7-10?<br>A science course has a responsibility for the social development of the child. It should build up a student's independence (of the teacher) and self-reliance, and avoid an authoritarian approach in its materials. | These aspects of the personal developmer of pupils are of fundamental importance to the Project:<br>- autonomy<br>- self-directedness<br>- social responsibility<br>- commitment to enquiry as a way of operating<br>- understanding of man's biological inheritance and its limitations<br>- capacity to react to environment with understanding rather than fear. |
| 1.2 | The pupil's immediate environment should form starting points for introducing topics. Interest is not necessarily related to the content of the materials, but to how they are treated. | The pupil's immediate environment and interests should be one important determinant guiding the types of material needed at this level. This does not preclude the possibility of creating a relevant environment in the course of the learning process to meet specific objectives. This implies that more than one set of materials may be needed to meet individual differences. | The pupil's immediate environment and interests should be considered as<br>1) powerful motivating influences<br>2) a starting point for compensating action<br>3) a source of raw data for study of sociological interactions<br>4) a stimulus for the encouragement of lasting interest in science. |
| 1.3 | It is impossible to predict future needs of the individual. Our best bet is that the immediate future is an extrapolation of the present, and thus students should be prepared to meet the trends of the present. | The course should prepare pupils to make more responsible contributions in a science-based society. Future needs can be catered for by involvement in suitable activities designed to provide information, process skills and desirable attitudes towards science. The course should provide a resevoir of science-trained individuals for vocations in science. | The student should be aware that society changing because of the interaction betw science-based technology and the environment and that there is a need to make tentative decisions about issues which arise from such interactions. The motivational force of vocational interes should be recognized. Students should b prepared for the possibility of changes (e.g. in vocation, in leisure, in the pla of a participating citizen in a planned society) due to advances in technology. |

| | | | |
|---|---|---|---|
| 1.4 | Whatever approach is used, the pupils will end up with a great body of knowledge in any science course. This will not necessarily meet all of the State requirements, but States can omit or add to ASEP to meet their own requirements<br>Pupils should gain sufficient data to help them to make informed decisions in areas related to science. | This is the unique contribution that science teaching can make. A basis for factual content is necessary, but the choice of such content is less important than that a few powerful ideas of science be presented. Doubt was expressed by a minority as to whether these powerful concepts are the most important things for teaching science in grades 7-10. | The acquisition of a substantial body of scientific knowledge is not a prime aim of the Project but some of this knowledge should be readily accessible to students when they enbark on individual exploratory experiences.<br>The students should be able to recall a sufficient number of concepts and principles (to be determined by the Project) and to acquire a suitable vocabulary to have access to and to communicate about the "great body of scientific knowledge". |
| 1.5 | If teaching leads into areas close to the "big ideas" of science, it is worth while extending these areas to teach the ideas, particularly in the later stages of the course, because these may have some surrender value later on. | The existence of separate scientific disciplines is acknowledged, but an integrated approach seems desirable. Separate disciplines represent different avenues for providing new knowledge, and for asking questions about problems in science.<br>Behavioural sciences e.g. psychology, anthropology, should be included as part of the integrated approach. | The existence of these disciplines is a fact of science but the importance of separate disciplines is subsidiary to all of the points above (1.1-1.4). |
| 1.6 | Little attention should be paid by ASEP to the specific demands of higher education. Students should be stimulated to wish to continue to study science. | Any course for grades 7-10 is seen as less likely to be a terminating course, in view of the increasing numbers of pupils remaining until grades 11 and 12. Demands of higher secondary and tertiary education are subordinate to other objectives of the course designed for grades 7-10. It is emphasized that the more able students should be adequately catered for. | The requirements of upper secondary education should not determine the content of ASEP materials. However we would be doing a disservice to a proportion of our students if we ignored the quantitative thinking required as a background to higher levels of education. |

| No. 1 Syndicate | No. 2 Syndicate | No. 3 Syndicate | No. 4 Syndicate |
|---|---|---|---|
| 2. General dissatisfaction with the fundamental aim. What does "science-linked" mean?<br>It is too general - what is unique about science? The word "autonomous" neglects the social aspect of scientific activity. The aim presents science as a passive thing, rather than one of active involvement.<br>WE BELIEVE THAT the fundamental aim of the Project is to draw upon the whole body of science to provide experiences which help the child to develop intellectually, and to be aware of the knowledge and techniques of science in order to appreciate their usefulness in understanding and adapting to the environment. | The group, with minor reservations, is in agreement with the "fundamental Aim of the Project" as stated on page 8 of the paper by the Director; however many members of the group feel that selection of the topics should be on the basis of important principles of science; and that the quality of social responsibility should be added to those of autohomy and self-direction.<br>One member recommends (with majority agreement). The Project must make decisions about what the pupils shall learn, i.e. about content.<br>One fundamental aim of the Project is to ensure that the pupils understand this selected knowledge. This does not mean that all pupils attempt to attain the same knowledge objectives or that they progress at the same rate.<br>The knowledge is selected from the general body of knowledge contained in the scientific disciplines.<br>Many criteria are involved in this selection. Whether material is "relevant, interesting or meaningful" the child is not the sole criterian for this selection. | After the words "of his environment and to" delete the original words and replace with "develop attitudes which will increase his ability to cope with any new environment as an independent individual who is fully aware of his dependence on others". | The majority of the syndicate were dissatisfied with the inclusion of the words "autonomous self-directed" and would like these terms clarified. One member wishes to submit the following as an alternative statement "the fundamental aim of the Project is to develop materials to provide science linked experiences appropriate to each child's individual needs which will assist him to learn about content and processes of science, to grow in his understanding of his environment and to increase his ability to cope with his environment.<br>(Doubtful words underlined) |

## TUESDAY JANUARY 20

The kinds of materials to be developed by the Project considered against the wider perspectives of learning and teaching

morning : two papers
afternoon : syndicate discussions
evening : plenary session

# THE KINDS OF MATERIALS TO BE DEVELOPED TO FOSTER THE AIMS OF THE AUSTRALIAN SCIENCE EDUCATION PROJECT - PROBABILITIES AND POSSIBILITIES

## PREAMBLE

In determining the framework within which the materials development area of the Project will operate, the following aspects must be considered

(1) the purposes, aims and rationale for the Project

(2) available time and finance

(3) variables relating to the school population concerned
- children, teachers, schools, communities, localities, etc.

Some of the decisions concerning this framework have already been made - the Project has been established, with specific purposes, duration, funding, staffing, administrative structure and advisory bodies. The proposed aims and rationale have been presented and discussed. In this paper, other areas in which decisions have yet to be made are examined and recommendations are put forward for consideration by the Project and its advisers.

## THE RANGE OF MATERIALS TO BE DEVELOPED

The term "materials" is taken to embrace all that could be useful to the teacher in the classroom, including printed matter for use by teachers and students, plus accompanying audio-visual aids, laboratory equipment, specimens, models, etc. Most of the kinds of materials to be developed by the Project are in use in schools. Emphasis will be placed on supplying particular items not already available rather than development of new kinds of materials. Most of these items will be designed, produced in trial form, tried in classrooms and prepared for production on the open market, by the staff of the Project. Some of the materials will be prepared by outside bodies, advised by Project staff. Where existing materials can be used, their source and availability will be made known in the Project printed materials. Some materials could be developed by modification of existing materials.

It is expected that materials in most of the following categories will be available as the result of work by the Project:

1 Printed matter - predominantly verbal
predominantly non-verbal

2 Audio-visual aids
- charts
- photographs
- audio tapes
- overhead projector transparencies
- 8 mm film, including loops
- 16 mm film
- 35 mm transparencies
- models

3 Equipment for teacher and student use

4 Specimens - for biological and earth sciences

In making the decision whether or not a given item of material will be produced a compromise will have to be made between the value of the item concerned as a means of achieving the objective desired and its cost to the Project and/or the school.

Recommendation 1 Where practicable, the Project should make available materials that are best suited to achieving the learning task desired but should take into account what is already available and the cost of production and/or supply to schools of any new items concerned. Where possible, use should be made of the materials already in or available to schools.

## MATTERS CONCERNING ALL MATERIALS PRODUCED

### A Distribution of materials over the four grade levels

The materials produced should be distributed over the four grade levels for NSW, Vic. and Tas. and usable over three grade levels in SA, WA and Qld. Since the ages of children in the three grades in SA, WA and Qld. fall within the age range of children in the four grades in Vic. NSW and Tas. then the task of meeting this requirement is not so formidable, provided that the materials are not tied closely to specific grade levels.

The ages of the children concerned provide some evidence of the overlap between grades.

The total age range is about 8 years. About 99% of the total Grade 7-10 population are within a 6-year range and about 87% are within a 4-year range. The distribution of ages on 1st August 1967 over all States at Grades 7-10 level excluding children in special classes was as follows:

| Age | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18+ |
|---|---|---|---|---|---|---|---|---|---|
| % of total | 0.005 | 3.8 | 19 | 25.2 | 25.3 | 17.5 | 8.6 | 0.5 | 0.1 |

It could be argued that materials should be developed for the 12-15 years age group and that these materials would be suitable for the remaining 13% of children. This could be so. The 11 year olds, as a group, would probably be an able group and so could cope quite well with materials prepared for the 12 year olds. On the other hand the 16+ year olds are likely to be a less-than-average group and would require special attention. Neglect of this group cannot be justified on educational grounds.

The average age range for each grade level over the six States is shown below (three-grade States are included under 8-9-10).

| Grade 7 | Grade 8 | Grade 9 | Grade 10 |
|---|---|---|---|
| 12.9 - 13.1 | 13.4 - 14.1 | 14.4 - 14.11 | 15.3 - 15.11 |

Materials produced for 12-15 year olds would be suitable for most of the pupils in the four grade levels concerned but some provision would need to be made for the below average 12 year olds and the above average 15 year olds.

One basis for deciding the distribution of materials could be the age level of children concerned. For example, the available work time for materials development could be evenly distributed over the four main age groups - 12, 13, 14, 15 years.

Since there is a considerable range of abilities in any one age group, an alternative, which involves overlap of age groups, could be to divide the total range of abilities into stages similar to those described by Piaget and based on changes in thinking ability in relation to development from dependence on concrete situations to ability to think in abstract terms without the aid of concrete "props".

Stage 1 materials could be concerned mainly with experiences in concrete situations, handling actual objects, equipment, organisms, etc. in actual situations. The situations could be chosen partly for background experiences in developing science concepts e.g. background to measuring lengths, areas, volumes, weights and to developing ideas of seriation, classification, and systematic investigation. The Stage 1 experiences could be investigative and concerned mainly with the development of techniques of scientific inquiry, using the processes of science.

Stage 2 materials could be regarded as representing the transition between Piaget's concrete and formal stages. Experience with concrete situations would be regarded as a necessary preliminary to the development of more theoretical relationships within the content studied. Attention would be given to more demanding aspects of scientific inquiry, such as formulation of simple "models", the examination of possible consequences, statement of hypotheses, and ways of dealing with extraneous variables by omission or by neutralization (control).

Stage 3 materials would be concerned with more abstract thinking including situations where ideas and/or symbols are manipulated in the absence of concrete examples, the development and study of models and theories, the consideration of possible consequences in situations where certain variables can be controlled and the use of calculations to refine explanations and predictions.

It is possible that a small proportion of the children in Grades 7-10 would spend most of their time on Stage 1 materials. Most children would spend a short time on Stage 1 materials and most of their time on Stage 2. Some children may spend little or no time on Stage 1, some time on Stage 2 and some time on Stage 3. It is feasible that tests can be developed to assist the teacher to determine what type of materials are best suited to each individual in his class.

This alternative, of stage-based materials, would provide better freedom of choice for the teachers and educational systems concerned, enabling tailoring of programs to the needs of the children.

Recommendation 2 Materials should be produced for three stages of development in children, based on ability to handle abstract ideas with the limited use of concrete "props".

## B The school environment

Most of the materials should be directly concerned with or arise from aspects of the child's environment. Experiences that are relevant to the child and which are reinforced in everyday activities are most meaningful and most likely to be remembered and incorporated into the child's behaviour.

The child's environment includes his body and personal behaviour; the structure and behaviour of other people and other organisms; his home; man-made structures, appliances, machines; the earth, sea and sky; and problems associated with life in this environment. The school environment, which includes the buildings, grounds, facilities, the community itself, and their physical, biological, and social aspects is, in effect, the environment of the child.

All schools will have some features in common but there will be many differences among schools. It will not be possible to cater for the range of differences throughout Australia but assistance can be provided to enable teachers to relate most of the learning to the local situation.

Recommendation 3 As far as possible, materials produced should be related to and adaptable to the student's environment. Teachers should be given assistance to enable them to make maximum use of the school environment.

## C Teachers' skills and preferences

Teachers differ in their abilities to use instructional procedures. This can be due to lack of knowledge but is often due to personality traits. Some teachers are not effective as lecturer-demonstrators. Others find difficulty in controlling the activities of a class in which students are working at their own rate or on different activities. Research evidence shows that a teacher is more effective when teaching in a manner suited to his own personal abilities and beliefs.

Irrespective of teaching ability, most teachers prefer to develop an approach and to select materials that best suit the needs of the particular class concerned.

Sufficient diversity and flexibility of materials should be provided by the Project to enable teachers to select those best suited for the particular teacher, children and school concerned. Some sequences should be included to cater for development in a given direction but these should be limited in length and, as far as practicable, selection and sequencing of topics should be a matter for school and teacher decision.

Recommendation 4 As far as is practicable, materials provided should be such that teachers can use them according to their own particular skills and preferences and to the advantage of the students concerned.

## D Classroom facilities available

In the ideal situation, most science periods are taken in rooms well suited for student activity. If these facilities are not available the next best situation involves the use of rooms not specifically set up for activity. This creates some problems in adapting the rooms for the use required, including supply and storage of equipment.

Recommendation 5 It should be assumed that the bulk of the equipment required will be available in the schools. Most of the activity exercises included in the materials should require the use of simple, readily available equipment.

Science is taught in many different types of classroom including those unsuitable for student laboratory activity and teacher-demonstration, those suitable for teacher demonstration but not for student activity, and those suitable for both.

Evidence and opinion both point strongly to the necessity for student activity as a basis for science learning.

Recommendation 6 In development of the materials it should be assumed that students will be taught in rooms in which individual activity can be undertaken.

Although most teachers will have access to a good range of audio-visual equipment, there is the problem of whether the equipment can be available for use at the time or in the place desired.

Research has shown that audio-visual aids are more effective when used as an integral part of the learning sequence.

Recommendation 7 Audio-visual materials should be produced to supplement the learning materials. Where these are made an essential part of the materials due account should be taken of the problems of availability of appropriate equipment and classroom facilities.

Reading about science is an important part of collecting information. Students should be able to do this during and outside of school time. School and municipal library facilities will be valuable sources of reading materials but will not be readily available to all pupils.

Recommendation 8 Reference reading materials that are considered to be highly desirable for all students should be produced as part of the project materials and in a form that can be made readily available to all students. Existing reference materials should be screened and appropriate information on them should be provided in the Project materials.

## E Learning approach

An inquiry approach is favoured by most science educators today. This approach involves active student investigation of situations in order to determine a pattern or relationship not known to the student. It can embrace posing questions to be answered, collecting information, looking for patterns and relationships, stating inferences and conclusions, making predictions, etc. Emphasis is placed on the validity of conclusions reached in terms of consistency with information available to the student. The student can be required to concentrate on certain aspects of inquiry at certain times in order to learn certain techniques or procedures or can be permitted to investigate freely along lines of his own determination.

Apart from the fact that an inquiry approach is consistent with the procedures of science it has been shown to be very effective in producing gains in learning, long-term retention and attitudes.

The extent to which the inquiry should be guided by structuring of the learning materials appears to depend upon the objectives desired. This is discussed in relation to the design of the printed materials, in the next section of this paper.

| | |
|---|---|
| Recommendation 9 | In the materials an inquiry approach should be used predominantly. |

F Activity of students

Research evidence indicates definite advantages to be derived by active participation by students. In science, students can participate in discussions, read and search out information from published materials, carry out laboratory and field work, prepare and present reports on findings, and assist in planning individual and class work. Research has shown that all of these activities can be used to advantage. Outcomes that can be improved include attitudes to school and instruction, understanding, retention, critical thinking, creativity and interest.

Evidence shows that low ability as well as high ability students can benefit from activity-centred experiences.

| | |
|---|---|
| Recommendation 10 | Materials developed should be based on student experience in carrying out laboratory experiments and investigations. Provision should be made for active student participation in most phases of classroom work at most times. Experiences incorporated should add to the intellectual and social development of the child and lead to understanding consistent with that development. |

G Rate of working

It is well known that children work at different rates but the degree of difference is not well known. Experience with the JSSP materials suggests that the rates can differ by at least a factor of 3 i.e. some children were able to complete a given quantity of work in one-third of the time taken by the slowest class members.

Whether a class is organized for individual progress or for group progress the difference in rate of working is present, except that in the latter situation, it is less obvious. Provision of additional materials for enrichment and extension can provide for those who work faster and for those whose interests lead them to additional science activities out of class time. These additional materials could include supplementary reading materials, audio-visual materials, and equipment or specimens.

Slower workers benefit from experience with enrichment and extension materials and should be given the opportunity to do so.

| | |
|---|---|
| Recommendation 11 | All materials produced should contain portions for enrichment and extension. Some materials should be designed to facilitate individual progress. |

H Attitudes to teacher, school and studies

While the area of interests and attitudes has not been clearly defined to the satisfaction of all concerned, it is generally agreed that there are certain "attitudes" that are desirable in that they indicate a positive approach to teacher or school or science or study, etc.

Student attitudes develop as the result of motivation, group dynamics, classroom learning procedures and out-of-school factors.

Research indicates that motivation is improved by active participation in the learning process and independence from teacher imposition of direction; a balance must be made between group needs and individual needs; inductive methods are better than deductive methods for attainment of scientific attitudes and positive attitudes to instruction; programmed instruction, if used to excess, can lead to negative attitudes; a multi-media approach can increase student interest; group dynamics are complex and no one method of grouping necessarily leads to better motivation or achievement; the problem-solving approach can produce greater growth in personal adjustment and attitudes towards school than a traditional approach; interest level of low interest students can be raised by giving supplementary learning experiences, using activities that are enjoyed.

Recommendation 12 Positive attitudes to science and to the learning situation should be encouraged by incorporating in the instructional materials student participation in problem solving, opportunity for students to follow their own ideas and interests, aspects of direct and immediate concern to students, variety in types and presentation of materials, and by making the materials interesting and attractive to both students and teachers.

## MATTERS CONCERNING THE DESIGN OF PRINTED MATERIALS

### A Guide to teachers

Teachers differ in their experience, knowledge, skills and attitudes. In-service education courses can assist teachers to accommodate to the use of new curriculum materials but certain variables must still remain.

There is a wide spectrum of knowledge, experience, and skills among teachers of Grades 7-10.

The current educational climate in most Australian States favours giving schools the responsibility for selecting and putting into practice the program for their own classes, and actively and continuously reassessing that work in terms of their goals. It is expected that the Project will make available materials in sufficient variety and quantity that schools and teachers will have some freedom of choice. It is hoped that the quantity available will be in the vicinity of twice that needed for average students to cover fully the three or four years of schooling involved. However, the fact that there will be an opportunity for choice means that teachers should be advised on the characteristics of the materials to assist them in making a choice.

Recommendation 13 Materials should provide a minimum basic guide for teachers that are well qualified and experienced. Supplementary information on the science involved should be available for teachers who lack knowledge of that area of science. Supplementary information on laboratory techniques should be available for teachers who lack experience in the school laboratory. Characteristics of all materials in terms of the outcomes to be expected from their use should be described.

## B Structured materials

While an inquiry approach is favoured by most science educators today the extent to which this should be "open-ended" has been debated strongly. Both open-ended and structured materials have advantages for achievement of certain outcomes. The former have been shown to give experience in the planning and conduct of investigations and in problem-solving, without loss of achievement in learning of science content. However, structured materials promote more efficient learning of content and of skills. Retention is better with less structure but can be improved by deliberate reinforcement at intervals. Prolonged use of closely structured sequences can lead to loss of interest.

Within a set of materials on a certain topic, the use of structured materials in the form of "guided discovery" has certain advantages. Initial learning can be rapid and efficient and, provided that it is subsequently adequately reinforced, can be well retained. Such materials can provide a detailed guide to students for individual progress in such a way that much of the need for teacher supervision and correction is eliminated.

Open-ended materials offer little guidance and, hence, their outcomes cannot be specified as closely. However, they have advantages in facilitating divergent thinking in giving the students opportunity to use their own initiative and develop as autonomous, self-directed individuals.

Recommendation 14 Both structured and open-ended materials should be developed. The former should be used mainly where rapid learning of certain content or skills is required, the latter mainly where outcomes of autonomy and initiative are desired.

## C Sequences among the materials

Most science courses consist of sequences of topics arranged in a logical order. Most science teachers re-arrange the order of presentation of topics to suit their own ideas and the requirements of the class. However, for one topic taken in successive years there can be a graded sequence of difficulty. In addition, some topics are pre-requisite to others.

It is suggested that the materials should be prepared in such a way that such sequences are kept to a minimum. The extent to which this is feasible will be investigated in the first trial of the materials.

This implies that there will be a relatively small quantity of material considered essential for all students. If there is to be any essential material it is necessary that it be covered by all children before they leave school.

The 1967 figures for the total school population at each grade level throughout Australia, given as a percentage of the total population at Grade 6 level, are as follows:

| | Grade 7 | Grade 8 | Grade 9 | Grade 10 | Grade 11 |
|---|---|---|---|---|---|
| % of Grade 6 | 100 | 96 | 84 | 64 | 29 |

Fensham (Education News, October 1969) gives figures for drop-out from science (including those that drop out from school) for students in Victoria.

| | Grade 7 | Grade 8 | Grade 9 | Grade 10 | Grade 11 |
|---|---|---|---|---|---|
| Boys | 0 | 0 | 3 | 27 | >66 |
| Girls | 0 | 0 | 6 | 31 | >66 |

Allowing for possible error in attempting to generalize from these figures it is obvious that there is some loss of students from science at Grade 9 level, a considerable loss at Grade 10 level (30-40%) and a minority continue with science studies at Grade 11 level (less than 40%). It is assumed that this situation may change in the direction of increased retention in Grades 9 and 10 but that the drop-out will be appreciable for some time to come.

So that all students can receive experience with the materials considered to be essential for all school leavers these materials should be written at Stage 1 or 2 levels, preferably, and teachers' attention should be drawn to them.

Recommendation 15 The materials should provide mainly for the science education of children who do not continue with the study of science beyond Grade 10. Any aspects considered to be of sufficient importance to be studied by all children should be covered no later than the end of Grade 9. Sequences among the materials should be kept to a minimum to give teachers maximum freedom of choice.

## D Reading ability

Evidence shows that the range of ability (IQ, reading, mathematics) at any one grade level is equal to or greater than 7-8 years. Figures presented by Parker (in Schooling for Individual Excellence) for reading ability of Grade 5 children in U.S.A. are as follows:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| % of students | 1.6 | 4.0 | 6.7 | 12.7 | 50 | 12.7 | 6.7 | 4.0 | 1.6 |
| Reading grade level | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

These figures indicate that only 50% of the children are at the stated grade level, approx. 89% are spread over a six year range and approximately 97% are spread over an eight year range.

If it is assumed that there is a similar spread of reading ability in each of Grades 7-10 in Australian schools then the spread of reading ability over the four grades is as follows:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reading grade level | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| % of total students | 0.4 | 1.4 | 3.1 | 6.3 | 18.3 | 20.5 | 20.5 | 18.3 | 6.3 | 3.1 | 1.4 | 0.4 |

If these are grouped the distribution becomes:

| | | | | | |
|---|---|---|---|---|---|
| Reading grade level | 3-4-5 | 6-7 | 8-9 | 10-11 | 12-13-14 |
| % of total students | 4.9 | 24.6 | 41 | 24.6 | 4.9 |

While it would not be feasible to produce materials at many different reading levels, it may be possible to cater for the three main levels 6-7, 8-9 and 10-11 with some supplementary materials at 4-5 and 12-13. The Grade 6-7 level materials would be suitable for average readers in Grade 7 and below average readers in Grades 8-10; the Grade 8-9 level materials would be suitable for above average readers in Grade 7, average readers in Grades 8-9 and below average readers in Grade 10; the Grade 10-11 materials would be suitable for above average readers in Grades 7-9 and average readers in Grade 10.

Recommendation 16 Materials should be produced for three main levels of reading ability - Reading Grades 6-7, 8-9 and 10-11, with some supplementary materials at Grades 4-5 and 12-13 levels. Usually, any one portion of materials should be written at one reading level only but several reading levels could be represented in a set of materials.

## E Individual and group learning

In the usual science class learning situation, the class behaves as one group with common learning objectives. Sometimes subgroups are recognized by the teacher and are given differential treatment in order to bring a greater proportion of children to the desired objective. Seldom can a teacher provide for different objectives for different groups.

Immediately subgroups are recognized, the teacher's task of imparting information and checking that the work has been completed to the required standards is multiplied. There is a limit to the number of groups that can be managed by one teacher but this limit is determined partly by the availability of materials that enable children to work independently of close supervision and assistance from the teacher.

It is not desirable that all class work be done by students without guidance and assistance from a teacher or without occasions on which groups, large or small, gather to discuss, plan and evaluate.

It is proposed that, for a given topic, the ASEP materials will contain some portions that can be used by students, working as individuals without the need for close teacher supervision or assistance. However, the work of each topic should be directed by the teacher who will organize the necessary facilities, promote and control discussions and, in consultation with the students, guide directions to be taken by individuals or groups.

Recommendation 17 Materials for a given topic of study should include portions that can be used by students working independently of the teacher but the responsibility of organizing the over-all work on that topic will be the teacher's.

## F Assessment of progress

At various times both the teacher and the student need to know the extent to which learning has been achieved. The need for self-assessment by students is greater when individuals in a class are progressing at different rates or are using different materials.

Recommendation 18 The materials available should include tests and other assessment instruments for use by teachers and students.

## G Subject matter to be covered in the materials

This can be broadly subdivided into five categories

(1) those aspects concerned with attitudes of students
(2) those aspects concerned with manipulations of equipment and materials
(3) those aspects concerned with science content i.e. knowledge of facts, generalizations, systems, principles, laws, procedures, etc.
(4) those aspects concerned with environmental applications of science
(5) those aspects concerned with extension of knowledge, including the use of science processes i.e. ways of solving problems by planning and conducting investigations, evaluating and extending findings, communication to others, etc.

It is proposed that most of the student activity will be concerned with aspects 2 and 5, 2 being a part of 5. Since the emphasis is on student activity and student inquiry, the use of scientific inquiry procedures should be the approach adopted in most of the materials.

With the emphasis on the importance of relating the materials to the environment of the children, it is proposed that most of the inquiry will be concerned with aspect 4 i.e. with aspects of science that can be dealt with in the context of the child's environment. Selection of these aspects should be based partly on the structure of scientific knowledge and partly on what is considered to be important to give the child an understanding of his environment. It is proposed that at least 70-80% of the materials will relate directly to the child's present environment.

In dealing with the environment, the structure of scientific knowledge will be kept in mind. It is believed that most of the requirements of State science syllabuses can be met in the context of the environment. However, there will be certain more abstract parts of science and some more advanced knowledge that could contribute to the intellectual development of some of the children and which, hence, should be included.

It is proposed that the materials be prepared for the three stages previously described in such a way that aspects of science not directly related to the child's environment cannot be included in programs for Grades 7 and 8 but these will be available for Grades 9-10 classes if teachers require more academically oriented materials.

Recommendation 19

The subject matter of the materials should be concerned with attitudes of students, manipulation of equipment and materials, science content, environmental applications of science and the extension of knowledge, including the use of science processes.

All materials should be concerned with the extension of knowledge and the development of desirable attitudes and should be consistent with the structure of scientific knowledge but materials concerned with aspects of science not of immediate relevance to the environment should be limited to use in Grades 9 and 10 and comprise less than 20% of the total materials developed.

## H The extension of knowledge

Emphasis will be placed on the use of procedures of scientific inquiry as a means of extending knowledge. The goal will be to make each individual as familiar as possible with scientific processes and as close as possible in this respect to an autonomous, self-directed individual.

The kinds of abilities to be developed include ability to plan an investigation, state a problem, outline a procedure, conduct an investigation; organize data by use of such techniques as classification, tabulation, serial ordering, graphing, diagrammatic representation and statistical analysis; present information verbally and visually, determine sources of error; extend information by inference, deduction, prediction, extrapolation, synthesis of models, etc. Critical appraisal leading to rational decision making on the basis of available evidence will be emphasized.

## I Knowledge of science

In most cases, learning experiences will be selected from subject disciplines, not because we think children need to know some physics, some chemistry, or some biology, but rather because the kinds of science learning available within the domains of these sciences are meaningful to the children in their present environment, and at their present stage of development. Emphasis will be given to social orientations of science - the relationship of science to human affairs.

There are certain "big ideas" of science that are potentially valuable to all children in enabling them to interpret their environment, for example, particulate nature of matter, energy interchanges, genetic stability and variation. It is possible that some of these could be considered as essential, the remainder as desirable. Such "ideas" could constitute unifying themes throughout the materials and can be presented as tentative but adequate representations of known phenomena.

Some learning experiences will be concerned with man as an individual in a biological environment - his structure and behaviour compared with the structure and behaviour of other organisms, reproduction, growth and development, genetics and variation.

Some learning experiences will be concerned with man's interaction with his environment - extension of abilities by use of machines, instruments, computers, etc; his use of his environment to meet his needs, effects of his use of his environment, environmental factors that affect man; problems of over population, conservation, pollution, radioactive fallout, drugs, organ transplants, etc; the need to improve the environment for future man.

Some learning experiences will be concerned with science as a part of culture - the development of scientific thought; its influence on history, art, literature, etc.

Only a limited sample of the possible range of coverage of materials can be prepared. Evidence from the trials will assist the Project to determine which experiences are more likely to be effective.

## FORMAT OF PRINTED MATERIALS

### A Flexibility

Conventionally, classroom printed materials have consisted of textbooks for the students, supplemented by reference books and notes for the guidance of the teacher.

A bound book has the advantage of containing, in compact form all the work for a class for a year. It has the disadvantage of limited flexibility and scope. Cards have an advantage for individual progress of students but create problems in organization and maintenance.

For maximum flexibility in the sense that a teacher can make up a program from a number of possibilities, the materials should be in the form of small portions e.g. booklets and sheets but the problem of the basis on which these portions may be selected and how they can be combined when selected could be great.

It is proposed that the trials of materials should include trials of the possible ways in which a variety of materials, produced in discrete, small portions, could be combined to make coherent programs.

Recommendation 20 The materials produced for the first trial should be in small, discrete but related portions that offer a variety of possibilities for combination. During the trials, ways of combining the various portions should be investigated.

## B Organization into units

It is intended that the printed materials for the first trial include

- teacher's information, in booklet form
- worksheets for student use, in pads for class use
- tests, in booklet form
- reference booklets
- learning instructions, in booklet form which could, at a later date, be converted to cards
- remedial portions, in booklet form
- enrichment portions, in booklet form.

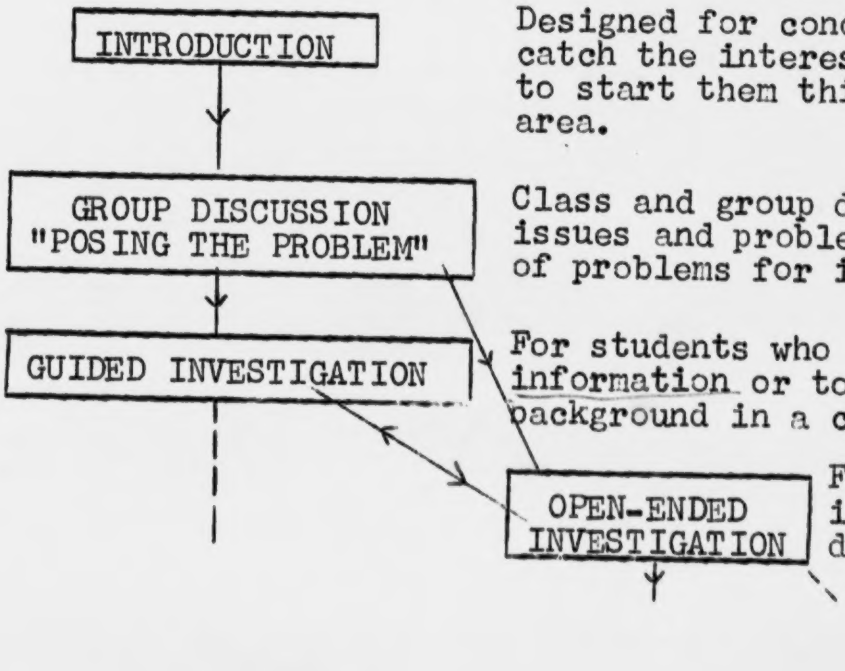
These will be produced separately (i.e. not bound together) but will be combined probably by some form of loose binding in "units" of classroom work, based on given topics of study.

It is proposed that each "unit" would be

| | |
|---|---|
| short | (covering from 5 to 20 class periods, approx.) |
| self-contained | (containing all that is needed for study of that topic, assuming adequate lab. facilities) |
| generally independent | (some of the later units may have "pre-requisite" earlier units, but this type of sequencing would be kept as low as practicably feasible) |
| flexible | (should be adaptable for use with different classes, student interests and abilities and teaching methods) |
| investigative | (both guided and open-ended investigations would be integral) |
| self-evaluative | (evaluation would be integral) |
| interesting | (involve real-life situations and experiences for pupils and teachers) |
| challenging | (for more capable students) |
| informative | (add to children's knowledge, experiences) |

usually concerned with some aspect of the total environment of the child.

The unit of work could be broadly structured as follows:

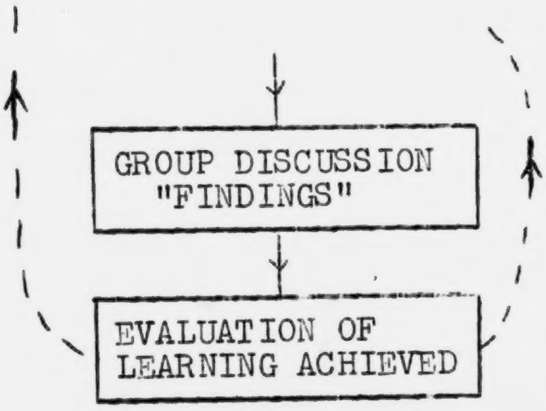


Designed for conduct by the teacher, to catch the interest of the students and to start them thinking about the topic area.

Class and group discussion of relevant issues and problems posed. Selection of problems for investigation.

For students who need more background information or to extend their present background in a certain direction.

For students who elect to investigate without detailed guidance.



Group and, finally, class discussion of findings to the problems investigated. Some form of written communication of findings.

Use of instruments provided to assess the outcomes achieved.
Feedback to students.

Alternation between guided and open-ended investigation could be directed by the teacher or could be dependent partly on the interests of the student. Guidance could be given from the results of internal assessment tests.

| | |
|---|---|
| Recommendation 21 | The materials produced for the first trial should be in the form of units, with broad structure and characteristics as described above. |

C Relationships between units

All units will be related in that they will be dealing with certain aspects of the environment and/or science.

In order to develop some sophistication in the use of inquiry techniques and manipulative skills it may be necessary to require that certain techniques be mastered before others are attempted. However, it is believed that necessary sequences of units can be kept short and relatively few in number.

In the areas of knowledge of the environment and of science, certain sequences of units may be necessary but freedom for determination by the teacher should be given where possible. Certain desirable sequences for certain outcomes can be recommended. Examples of possible sequences of units for full-year programs can and should be given.

| | |
|---|---|
| Recommendation 22 | Sequences of units in which certain units are pre-requisite to others should be kept as short and as few in number as possible.<br>Desirable and possible sequences of units to achieve specified outcomes should be stated for the guidance of teachers. |

SUMMARY

In this paper, recommendations concerning the materials to be developed by the Project have been made. (They are listed in detail in Appendix 2.)

It is proposed that the materials should

1 be concerned mainly with the current development of children who will not continue with the formal study of science

2 relate directly to the child's present environment as far as possible, including its physical, biological and social aspects

3 be consistent with the structure of scientific knowledge and contain aspects devoted specifically to extension of this knowledge treating science as an integrated subject

4 follow an inquiry approach and develop competency in scientific inquiry

5 require and depend upon student activity

SUMMARY (contd.)

6 aim at developing positive student attitudes

7 include essential reference materials

8 contain portions for individual student progress

9 provide both structured and open-ended exercises

10 contain portions for enrichment and extension

11 include tests and other assessment instruments

12 include adequate guidance for teachers

13 cater for three main levels of reading ability

14 be organized according to three stages of child development, corresponding approximately to Piaget's concrete and formal stages and the transition between them

15 for the first trial, be produced in small, related but physically discrete portions

16 for the first trial, be structured in "units" of work, each covering a specific topic, with each unit as independent as possible from other units.

Each recommendation represents an issue upon which opinions differ. On some points agreement will be reached without difficulty. On others it may be possible to compromise by catering for two points of view. The extent to which this can be done will depend largely on the Project's resources and, in some cases, a decision may have to be made in favour of one direction and at the expense of another.

Whether or not decisions made at this stage are supported in practice will be revealed during the trials and evaluation of materials developed.

January 1970 LGD

## Appendix 1 : Examples of units

(1) Title Yabbies (alternatively 'Mice', 'Snails', 'Worms', etc.)

Introduction Suggestions for the teacher, including:

an excursion to catch yabbies

a film showing problems of yabbie damage to irrigation channels

unstructured period of observation of live specimens in the classroom.

### Posing problems to be investigated

Teacher's guide to suggest such problems as

(1) how to keep yabbies alive - needs for food, air, shelter, water
(2) what they are like inside
(3) how they reproduce and grow
(4) where they live and in association with what other life
(5) their behaviour under certain conditions e.g. out of water, in bright light, in detecting food, etc.

### Guided investigations

how to set up basic housing requirements
how to dissect
how to recognize the various external features.

### Open-ended investigations

Suggestions for experiments on feeding
Suggestions for experiments on behaviour
Suggestions on how to collect pond or river organisms

### Reference reading

Yabbies and other crustaceans
Life in a pond or stream
Crustaceans as food, including for aboriginals
Problems of yabbies in irrigation channels

### Audio-visuals

35 mm colour slides on kinds of yabbies and other pond organisms
Overhead projector visuals on structure
Film loop on life cycle
Film loop on body movements

### Review discussion

Suggestions for procedures to be followed in reviewing knowledge gained.

### Evaluation

Tests to enable children and teachers to evaluate progress in learning.

Appendix 1 (contd.)

(2) Title Sounds and Music

Introduction Suggestions for the teacher, including -

- organization of a "pop" concert
- a musical film
- unstructured "play" with an audio-oscillator
- unstructured "play" - making sounds from everyday things.

Posing problems

Suggestions for the teacher, including -

- how certain musical instruments "work"
- why adults like or dislike "pop" music
- how is a record made and how does it "work"
- why a guitar string makes a higher note when it is pressed.

Guided investigations

- how to vary the note produced by a string
- how to vary the note produced by vibrating air
- how to make an instrument to measure loudness
- the relationship between pitch and frequency
- how to make a simple recording.

Open-ended investigations

Suggestions for -

- conducting surveys of popular opinion
- experiments with musical instruments
- testing for combinations of notes that are in harmony
- tracing the history of a musical instrument
- tracing the career of a pop group
- discovering the effect of pop music on society
- testing the effect of prolonged loud music or noise on hearing.

Reference reading

Several booklets on such topics as the history of music, music and dancing, the ways in which music has affected society, the instruments commonly played today, how a sound recording is made, the place of pop music in the modern world, the use of music in improving employment output, the importance of audio communication in the modern world.

Review discussion

Suggested procedures for reviewing and discussing what has been learned.

Evaluation

Tests to enable children and teachers to determine progress in learning.

Appendix 2

In this paper, the following recommendations have been made.

1 Where practicable, the Project should make available materials that are best suited to achieving the learning task desired but should take into account what is already available and the cost of production and/or supply to schools of any new items concerned. Where possible, use should be made of the materials already in or available to schools.

2 Materials should be produced for three stages of development in children, based on ability to handle abstract ideas with the limited use of concrete "props".

3 As far as possible, materials produced should be related to and adaptable to the student's environment. Teachers should be given assistance to enable them to make maximum use of the school environment.

4 As far as is practicable, materials provided should be such that teachers can use them according to their own particular skills and preferences and to the advantage of the students concerned.

5 It should be assumed that the bulk of the equipment required will be available in the schools. Most of the activity exercises included in the materials should require the use of simple, readily available equipment.

6 In development of the materials it should be assumed that students will be taught in rooms in which individual activity can be undertaken.

7 Audio-visual materials should be produced to supplement the learning materials. Where these are made an essential part of the materials due account should be taken of the problems of availability of appropriate equipment and classroom facilities.

8 Reference reading materials that are considered to be highly desirable for all students should be produced as part of the Project materials and in a form that can be made readily available to all students. Existing reference materials should be screened and appropriate information on them should be provided in the Project materials.

9 In the materials an inquiry approach should be used predominantly.

10 Materials developed should be based on student experience in carrying out laboratory experiments and investigations. Provision should be made for active student participation in most phases of classroom work at most times. Experiences inc planning incorporated should add to the intellectual and social development of the child and lead to understanding consistent with that development.

11 All materials produced should contain portions for enrichment and extension. Some materials should be designed to facilitate individual progress.

12 Positive attitudes to science and to the learning situation should be encouraged by incorporating in the instructional materials student participation in problem solving, opportunity for students to follow their own ideas and interests, aspects of direct and immediate concern to students, variety in types and presentation of materials, and by making the materials interesting and attractive to both students and teachers.

Appendix 2 (contd.)

13 Materials should provide a minimum basic guide for teachers that are well qualified and experienced. Supplementary information on the science involved should be available for teachers who lack knowledge of that area of science. Supplementary information on laboratory techniques should be available for teachers who lack experience in the school laboratory. Characteristics of all materials in terms of the outcomes to be expected from their use should be described.

14 Both structured and open-ended materials should be developed. The former should be used mainly where rapid learning of certain content or skills is required, the latter mainly where outcomes of autonomy and initiative are desired.

15 The materials should provide mainly for the science education of children who do not continue with the study of science beyond Grade 10. Any aspects considered to be of sufficient importance to be studied by all children should be covered no later than the end of Grade 9. Sequences among the materials should be kept to a minimum to give teachers maximum freedom of choice.

16 Materials should be produced for three main levels of reading ability - Reading Grades 6-7, 8-9 and 10-11, with some supplementary materials at Grades 4-5 and 12-13 levels. Usually any one portion of materials should be written at one reading level only but several reading levels could be represented in a set of materials.

17 Materials for a given topic of study should include portions that can be used by students working independently of the teacher but the responsibility of organizing the over-all work on that topic will be the teacher's.

18 The materials available should include tests and other assessment instruments for use by teachers and students.

19 The subject matter of the materials should be concerned with attitudes of students, manipulation of equipment and materials, science content, environmental applications of science and the extension of knowledge, including the use of science processes. All materials should be concerned with the extension of knowledge and the development of desirable attitudes and should be consistent with the structure of scientific knowledge but materials concerned with aspects of science not of immediate relevance to the environment should be limited to use in Grades 9 and 10 and comprise less than 20% of the total materials developed. — rest of materials will cater for at least 20% of requirements

20 The materials produced for the first trial should be in small, discrete but related portions that offer a variety of possibilities for combination. During the trials, ways of combining the various portions should be investigated.

21 The materials produced for the first trial should be in the form of units, with broad structure and characteristics as described above.

22 Sequences of units in which certain units are pre-requisite to others should be kept as short and as few in number as possible. Desirable and possible sequences of units to achieve specified outcomes should be stated for the guidance of teachers.

AUSTRALIAN SCIENCE EDUCATION PROJECT

GUIDELINES CONFERENCE

Paper 2
Tuesday, January 20

# "Learning and instruction - the kinds of pupil outcomes to be expected from different kinds of learning experiences".

M.L.Turner, La Trobe University

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The educational lecture has been defined as a discourse given to students with minimal interruption,the students being expected to make notes of anything that they judge may be of use to them. Given this definition some quite interesting commentaries can be made of lecturers who distribute prepared lecture notes and of students who copy verbatim the entire discourse of the lecture. The organizers of this conference have obviously decided that lecturers can be embarassed but that the audience must not be embarassed. Hence,they have provided copies of the lectures.

It has been argued that often,but not always,the lecture is at its worst as a learning experience when the discourse is an unleavened and circumscribed monologue on a limited topic or field of study with the lecturer in the dominating role of oracle,and where the intended learning outcome of the encounter between teacher,topic,and learner is the assimilation by the learner of pre-packaged information. The circumstances of this lecture are,if anything,the reverse of this. The topic is amorphous and the potentially relevant fields of study are many and diffuse,in none of which can I claim to be an oracle,and the principle intended outcome is to provoke thought leading to adaptation and accomodation. Even if I am successful in this intended outcome,this does not necessarily mean the lecture will be judged to be good.

The title of this paper,presented to me as a pre-Christmas gift, I have assumed constitutes a challenge to formulate and present what has not previously existed - a comprehensive and usefully valid psychological theory of school and classroom learning which can be applied to curriculum development and teaching. Since I am unequal to this challenge,I shall act more as a filter of other's empirical research findings and elements of theoretical conceptions. In doing so I shall not adopt a particular psychological position. Rather,I shall adopt the position being taken by an increasing number of psychologists, especially those returning to the problems of school and classroom learning,that many learning theorists have been acting prematurely in assuming that learning is a unitary phenomenon to be explained by a unique and singular theory and that the best research strategy is to pursue what are apparently different types of learning in their most appropriate environments - including the school and classroom.

At the risk of overemphasizing the point about the lack of an adequate theory,I would like to quote from Gagne and Rohwer (1969) writing in the 1969 Annual Review of Psychology.

> "Remoteness of applicability to instruction,we note with some regret,characterizes many studies of human learning,retention, and transfer,appearing in the most prestigious psychological journals. The findings of many studies of human learning presently cannot be applied directly to instructional design for two major reasons : (a) the conditions under which the learning is investigated,such as withholding knowledge of learning goals from the subject and the requiring of repititions of responses,are often unrepresentative of conditions under which most human learning occurs ; and (b) the tasks set for the learner (e.g. the verbatim reproduction of verbal responses,the guessing of stimulus attributes chosen by the experimenter,among many others) appear to cover a range from the merely peculiar to the downright esoteric. This is not to imply that such studies do not further an understanding of the learning process. However, it would seem that extensive theory development centering upon learning tasks and learning conditions will be required before one will be able to apply such knowledge to the design of instruction for representative human tasks."

## Is learning solely a function of features of the immediate school learning experience ?

The answer is clearly "No !". A very large number of variables have been shown empirically to be involved in the learning of one or more tasks by human subjects. However these variables may be codified and classified,it is clear that only a subset of them are initiated or come into operation in the immediate school learning experience and of these only a further subset are subject to more or less control by teacher,learner,institution,machine or other device.

Philp's (1968) classification of variables affecting the educability of the child suitably illustrates this point. (See Appendix I). It can be noted that it is only within the second of his three major categories that we are dealing with variables which are uniquely tied to the school,teacher,curriculum,and other aspects of the immediate learning experience,and,of course,in matters of control it is clear that variables of,say,teacher "personality"involve both practical and moral problems.

If,then,learning in school is not solely a function of features of the immediate school learning experience,how important are these features,especially those that can be easily and responsibly manipulated, compared with other features ?

It might be thought, for instance, that the immediate factors give the principal account of learning and that the others, separately or in combination, merely result in minor perturbations in the outcomes. This, however, is not the case. The other variables are very considerably implicated whether or not the learning is aggregated school achievement over a long term or achievement in a short specific learning task. For example, much recent major research has established the very considerable proportion of learning performance variance that is to be accounted for in terms of the language that the child brings to the school and of parental attitudes to education.

An essential qualification to this general conclusion is that the features of the school learning experience are fixed; that is, they are more or less the same for all the learners. The results I have been discussing arise when the educational treatment is more or less fixed for all learners. This, of course, is the problem of individual differences. Under fixed treatments, learners typically display different degrees and patterns of learning. When variables of the immediate school learning experience are manipulated resulting in changes in the average level of learning, there still remains as much(sometimes a little more, sometimes a little less)individual variation as before. When variables outside those of the immediate school learning experience are taken into account, a not inconsiderable proportion of the learning performance differences may be accounted for. Within Western cultures it appears that, under fixed treatments within learning groups such as school classes, but with some variation between classes, schools, school systems, and nations in the levels of the variables of the immediate school learning experiences, more of the overall individual difference learning variance is to be accounted for by variables outside the immediate school learning experience than by variables within it. This finding appears to be true for a very wide range of types of school learning, although the operative variables and the interactions betwenn them that produce the result are likely to vary from one type of learning to another.

It is important, therefore, to accept that if we have in mind for our students of science the attainment of a spectrum of outcomes - perhaps to be attained through a variety of learning experiences - then, unless we go some considerable distance towards solving the problem of individual differences, the spectra of individual students will be very different indeed and almost certainly more variable qualitatively and quantitatively than we might wish to consciously encourage.

It may, therefore, be important to ask are there any particular educational systems, that is particular forms or combinations of learning experiences, which can bring under some measure of control individual differences in learning.

Cronbach (1967) has considered the question : "How can instruction be adapted to individual differences ?",and has suggested that there are at least four broadly distinguishable patterns which provide for adaptation to individual differences in learning. The four patterns are as follows :-

1. Adaptation within a predetermined program.

In this pattern there is a single curriculum characterized by fixed goals and fixed instructional treatment. Traditionally,much universal public education has been of this pattern or an approximation to it. Two forms of adaptation to individual differences appear possible. By far the traditionally most popular form adapted chiefly by eliminating students. The less successful (or those who were too poor to continue) were eliminated. The social theory advanced in support of this pattern of adaptation has,and is,essentially that of "every child should go as far as his ability warrants".

The second form of adaptation has had a relatively long but chequered educational history. Instruction continues with individual students until mastery or a set criterion on component learning tasks is achieved. The non-graded school represents an example of a macro-adaptation of this form,while linear programmed instruction illustrates a micro-adaptation. The social theory advanced in support of this form af adaptation is that there are certain minimum learnings which every child of his day and age should acquire.

2. Adaptation by matching goals to the individual.

In this pattern there are several curricula each characterized by its own set of goals but for each curriculum there is a fixed instructional treatment. The adaptation to individual differences arises,according to this pattern,by determining in advance the child's prospective adult role (or,perhaps,some earlier occurring status) and assigning the child to that curriculum preparing for that role or status.

The social theory purporting to support such a pattern of adaptation is one version or another of the "hewers of wood and drawers of water" argument. Differentiated curricula of secondary education,especially in the earlier decades of development of public secondary systems,provide an example of such an adaptation.

3. Adaptation by erasing individual differences.

In this pattern,while the goals of the curriculum (or of each of several curricula) may be fixed,the instructional treatment is varied by varying its duration for individual learners. Thus,in this pattern while there is a fixed "main track" of instruction,variations is introduced by way of numbers of remedial adjuncts. Almost any form of remedial instruction provides an example. Contemporary examples of micro-adaptations of this kind are Crowder-type branching programs. "Headstart" compensatory education programs for the socially and culturally disadvantaged illustrate a macro-adaptation.

The social theory corresponding to this adaptation includes as an element the "compensatory principle" - as a right the child should receive compensation in learning for inhibiting factors over which he has no control.

4. Adaptation by altering instructional method.

In this pattern,as for the third pattern,the goals of the curriculum are fixed but the instructional treatment is varied. The distinction is that with this pattern genuinely different instructional treatments are used rather than remediation of a single main track. The theory is that according to prior differences in aptitudes for learning,different learners can achieve the same goals by different learning paths and methods. I know of no clear-cut operative educational systems to illustrate this pattern. The "superb" classroom teacher who provides deliberate and constant variation in his educational treatment of each child in his classroom is,perhaps, a hypothetical illustration. There are several recent psychological researches and a few pieces of curriculum experimenation in this pattern which have given the hint of promise for the future.

The social theory relevant here is the same as for the previous pattern.

All these patterns,in their theory and practice,are subject to criticism of both a social and psychological kind. The interested reader may wish to refer to Cronbach's article to follow this point further.

There are,of course,other reasons for curriculum development making a multi-track adaptation,but these adaptations are not to individual differences in learning. Teachers,because of different forms of qualification and experience,may be more competent to teach one track than another. Schools and school systems,because of their different value systems,may prefer to use one version rather than another. Political pressures may also give rise to a multi-track adaptation.

J.S.S.P. did adopt a policy of adaptation to individual differences in learning. A.S.E.P. may determine to do the same. While some compromise must obviously be made,I believe it would be a sad thing if adaptations to other circumstances predominated over adaptation to individual differences in learning.

## What form(s) of relationship exist between particular learning experiences and particular pupil outcomes ?

Despite the fact that I have asserted that no adequate theory exists linking learning experiences and learned outcomes,certain fairly general observations can be made.

1. The correspondences between learning experiences and learned outcomes are usually,if not always,not of the form of a unique one-to-one correspondence.

Any one particular learning experience,no matter how well-defined and discrete it may be,or appear to be,when learning occurs gives rise,usually,to a multiplicity of outcomes. The child intensively drilled in Latin and Greek roots may learn the roots and their meanings,transfer this learning quite well to learning the meanings of unfamiliar English words,fail to transfer this learning to learning the meanings of French words,and learn to dislike his English teacher. Intended and favourable outcomes,if they arise,are not infrequently accompanied by unintended and undesired outcomes.

Any one particular learned outcome may usually be obtained through different learning experiences. For example,there are very many learned principles that can be established by either deductive or inductive methods. Of course,this is not to say that on average the several methods are equally easy of application or equally effective or are accompanied by the same "incidental" learnings.

2. Not every child will learn or learn to the same degree when subjected to the same,at least nominally,fixed learning experience. Thus,at least in its practical aspect,school learning is probabilistic in character. No matter how exhaustive researchers have been in the attempt to take into account the non-instructional variables which may account for learning,there inevitably remains a proportion of unexplained individual-difference-in-learning variance. It may be that such residual variance can eventually be explained in terms of as yet unknown variables or of interactions between them,but it may be that in at least some forms of learning there is a genuinely random process or processes at work.

3. The more well-defined and discrete the learning experience and the more specific the intended learned outcome,the lower the extent of correlation between learning on different outcomes tends to be. That is,the more fine-grained are our curriculum's learning experiences the less likely it is that a general learning ability can be invoked to explain learning and the less likely it is that one can infer a learner's status in progress to a goal from his status in progress to another goal.

Taken together,these points illustrate the difficulties to be overcome in effectively monitoring individual and group progress towards the goals of the curriculum,especially under conditions of adaptation to individual differences in learning.

## What systems (Classifications,Taxonomies,etc.) exist for thinking about kinds of pupil outcomes and kinds of learning experiences ?

In general,I believe the following position holds with respect to the lists,classifications,and taxonomies currently available.

1. The majority refer to learned outcomes,and of the others most refer to learning experiences. There are few indeed which incorporate both outcomes and learning experiences.

2. The majority refer exclusively or principally to cognitive functioning,with the minority refering to affective or psychomotor functioning.

Thus while available systems may be valuable in bringing to mind outcomes or experiences that could otherwise fail to be considered,which I would regard as an advantage during the stage or stages when a curriculum development project is engaged in the process of derivation and selection of learning experiences,the present distribution of attention to outcomes and learning experiences in available materials may have the effect of producing an undesirable imbalance in such a project's immediate or eventual selection.

I shall not attempt to give an exhaustive coverage of all such systems known to me. The interested reader can be referred in the first instance to Wheeler (1967) and Turner (1969).

I shall give some attention to two systems which provide some useful contrasts despite the fact that they both give attention to relationships between learning experiences and learned outcomes. The first is provided by McLeish (1968) in a discussion paper from the Cambridge Institute of Education,and the second is provided by Gagne (1965) in his book,"The Conditions of Learning".

Although McLeish's paper is mainly directed towards higher education,this does not make it irrelevant for our purposes.

McLeish starts from the relatively popular position that teaching is a process concerned with facilitating learning and increasing its effectiveness and that learningcan be regarded as both a more or less enduring change in behaviour and an increase in understanding. He then suggests five broad categories of learning. In respect of the functions of the teacher and the commitment of the learner they range from the impersonal to the personal.

The five categories are Objective Information,Technical Skill, Social Competence,Personal Acceptability,and Self-Insight. (For McLeish's commentaries on these,see Appendix II)

He also describes a relatively large number of different modes of teaching. These are Lecture,Step-by-step Lecture-discussion, Demonstration,Controlled Discussion ("Socratic" method),Library Technique,Group Tutorial,Seminar,Critiques,Individual Tutorial, Experimental Laboratory,Project,Case Discussion,Free Group Discussion,Role-Play,Simulation Exercise,Programmed Material, Computer-assisted Instruction, Analogue Method, Counselling, Synectics, The Syndicate Method, Supervised Reading, and specially selected or prepared Films, Radio and TV Programmes, Audio-tape Recordings. (A selection of McLeish's descriptive definitions of these methods is given in Appendix III.)

McLeish then suggests that some methods are more appropriate than others for learning in each of the five areas he proposes, and further suggests that this is because of the different roles played and activities engaged in by teacher and learner in the various method situations. (Some indications of these roles and activities are provided by McLeish and are reproduced in Appendix IV)

The point of view which Gagne expands in his book can be given in his own summary :-

"There are as many varieties of learning as there are distinguishable conditions for learning. These varieties may be differentiated by means of descriptions of the factors that comprise the learning conditions in each case. In searching for and identifying these, one must look, first, at the capabilities internal to the learner, and, second, at the stimulus situation outside the learner. Each type of learning starts from a different "point" of internal capability, and is likely to demand a different external situation in order to take place effectively. The useful prorotypes of learning are those delineated by these descriptions of learning conditions."

While the book does not totally avoid issues of motivation, persuasion and the learning of attitudes and values, it explicitly sets out to consider learning of those skills and knowledges that have typically formed the content of school curricula.

Gagne recognizes eight types of learning, while acknowledging that there may be more. His eight types are Signal Learning, Stimulus-Response Learning, Chaining, Verbal Association, Multiple Discrimination, Concept Learning, Principle Learning, and Problem Solving.

Each type of learning is characterized by two sets of conditions, those within the learner, essentially prerequisite learned capabilities, and those of the learning situation. Gagne argues that for seven of the eight types there is conclusive evidence to support the proposition that there is an invariant order in which the types of learning are linked by this prerequisite relationship. Thus he claims :- problem solving requires as prerequisites principles which require as prerequisites concepts which require as prerequisites multiple discriminations which require as prerequisites verbal associations or other chains which require as prerequisites stimulus-response connections.

The two sets of conditions for each learning type, taken jointly, imply the characteristics (elements and sequence) of the instructional events necessary for learning to occur.

Only a complete reading of his book can do justice to his arguments and conclusions. Nevertheless,and at some risk of superficiality,Appendix V sets out Gagne's own briefest descriptions of these types of learning and of the characteristics of the instructional events necessary for their acquisition. In each case has been added examples of learned capabilities of an elementary scientific character which I believe may illustrate them.

Perhaps the strongest implication of Gagne's position for curriculum development and teaching,more generally,is that it is invalid,usually if not always,to use a single instructional method to teach what are the more familiar topics or units of work of traditional curricula. What is required is a task analysis. Not infrequently it is possible to identify the learnings that are seen as the most desirable and important intended consequences of teaching the unit. And again,not infrequently,it is found that these learnings are higher-order principles. It may then be possible to determine in turn the subordinate principles,concepts,multiple discriminations and so on upon which these higher-order principles are derivative. If any or all of these subordinate learnings are missing in the student they must be learned if the final intended learnings are to be achieved. And each such learning has its own set of distinctive necessary conditions. Thus,for Gagne,the effective curriculum unit is that devoted to the acquisition of a particular learning be it a higher-order principle,principle,concept,multiple discrimination, and so on.

What are the advantages and disadvantages of such systems ?

There are many obvious similarities and differences in McLeish's and Gagne's positions,as would be true of the authors of any number of systems dealing with systems of learned outcomes and/or learning experiences. Some,but not all of these will be mentioned in the course of considering the advantages and disadvantages of adopting and adapting one or more of such systems as one of the bases for work in curriculum development.

I have already mentioned as an advantage the point that such systems often bring to mind learned outcomes or learning experiences which would otherwise be forgotten. For example,does McLeish's classification suggest to you what might not have been considered before - that science education should,perhaps,make some contribution to the development of social competencies or personal qualities. Has role-playing or simulation exercises a place,or a greater place, in science education ? Or,considering Gagne,has science education to date been much too concerned with the early introduction of problem-solving,higher-order principles and given too little attention to the discriminations,concepts,and principles upon which he claims they are necessarily based ?

I have also already mentioned as a possible disadvantage the point that the too ready an adoption of any one system may,in fact, lead to the omission of very important categories of otherwise desired learned outcomes and of their appropriate learning experiences.

For example,would the exclusive adoption of Gagne's position result in the failure to provide for learning of kinds which would otherwise be judged an important result of science education ?

Another feature,which tends to correlate with the relative comprehensiveness of the system ,is the learning or re-learning (training or retraining) demands that the adoption or adaptation of one or more systems places on the curriculum worker and teacher. The more comprehensive the system the more intuitive its constructs and connections tend to be,the more its operations tend to approximate an art form,and the more open to chance events are the interpretations to be put upon it. The more focussed the system,the more analytic its constructs and connections tend to be,the more its operations tend to approximate a technology,and the less open to chance events are the interpretations to be put upob it. In either case the demands upon the relative novice in the system in order to come to grips with it are very considerable.

Which one of us has read more than a very little of the psychological literature or had more than an every day practical experience of the phenomena,empirical results, and concepts upon which Gagne has erected his conditions of learning ? Which one of us knows enough of role-playing,simulation,synectics, or computer-assisted instruction to judge,at least tentatively,whether or not or to what degree such learning experiences could be a useful part of a junior secondary science curriculum ?

Thus a possible disadvantage of adoption and/or adaptation of one or more systems is that the curriculum worker may misinterpret the system,or,if he does not do so,the teacher may still do so. This may be only another way of saying that representative practising teachers should,perhaps,be represented in a curriculum development project at all stages of its operations. It may also be only another way of saying that the education of the teacher is ,perhaps,more critical than the production of curriculum materials.

Another disadvantage,true of any system,is that they are never comprehensive enough as guidelines for all the decisions and operations of the curriculum worker or teacher. For example,neither McLeish nor Gagne have anything explicit to say about such very important matters as attention or motivation. I would guess that McLeish would see the mainsprings of motivation in social structure of the classroom or other learning environment and might endorse a relatively free or open system enouraging social interaction and permitting at least a significant degree of control by the pupil over the course of his learning experiences. He might thus be seen to be endorsing a form of extrinsic motivation. Gagne,I believe, would see the mainsprings of motivation in parameters of the learning task,for example in having learning tasks at an optimum level of difficulty,neiher so difficult that they will be avoided nor so difficult that it will only be attempted for some worthwhile extrinsic reason. Provision of the necessary conditions for learning,he could believe,probably goes close to achieveing the optimum level of difficulty in the learning task,with which the observational correlates of so-called intrinsic motivation are known to be associated.

But, of course, I might be wrong in my guess about what McLeish or Gagne think about motivation. Or if I am right in my guess I could be so for the wrong reasons. In either case the consequences for any curriculum I develop or teaching I do are probably in the direction of lowering its quality and reducing its effectiveness. (At this point I should perhaps say that I have done less than justice to the concepts of extrinsic and intrinsic motivation and that to the extent that they have validity neither can be avoided in school learning even if particular forms of either should be avoided.)

Another important matter on which nearly all such systems have nothing to say is that of the level of practical demands they are likely to make for their implementation in a practical system. For example, even if it could be shown empirically that computer-assisted instruction could be used to take over many of the teaching areas of the present curriculum with no loss in learning and, perhaps, some gains, it would seem highly improbable at the present time that the necessary costs could be met. The adoption of a system or systems necessarily carries with it hidden implications of at least logistical and economic kinds.

For what are very good reasons, most of the systems of learned outcomes and/or learning experiences that I know, are subject or discipline neutral. Further, they tend to be classificatory in character, that is, they consist of a series or system of generalized categories, rather than being keys to particular learned outcomes or particular learning experiences. Thus, the person wishing to apply the system still has much to do and frequently little to guide him in making the particular selections that will distinguish his curriculum. This is not necessarily an advantage or a disadvantage, but being alert to this fact is some guarantee that it will not develop into a disadvantage through the allocation of too little time or resources to this phase of activity.

The general feature of advantage in such systems is really counterpoint to the points of disadvantage that I have been mainly making. This is, that they do represent the consensus of other people's thought, intuition, experience and research. To the extent that this thought, intuition, experience and research has validity the greater the advantages are likely to be.

It might be thought that the relative advantages and disadvantages of these systems could be judged in terms of their products, that is in terms of their empirical validation. Whatever the merits of this suggestion, it does not seem possible at the present time for there are relatively few, if any, curricula which have adopted exclusively any one of the systems I know.

And this point supposes that the one system does not give rise to markedly different products. Thus,for example,Gagne's system was used to guide the development of the A.A.A.S. Commission on Science Education's elementary school curriculum project.

I believe it would be wrong to judge the merits or otherwise of Gagne's system solely in terms of the characteristics of the A.A.A.S. curriculum,or to infer that if the A.A.A.S. curriculum possessed a certain characteristic that this is an inevitable consequence of the adoption of the Gagne system. Thus for example,the A.A.A.S. curriculum might be called a closed curriculum in the sense that the choices of learned outcomes and learning experiences are not open to the child and,only marginally,to the teacher. This stands in sharp contra-distinction with other recent primary school science curricula,for example,Nuffield Junior Science,where very considerable choice of outcome and experience is open to the child and teacher. It would be my guess that if the A.A.A.S. and Nuffield curricula were compared as preparations for secondary and later science education in empirical fashion,Nuffield,on average,would prove the better. The basis for my guess would be that the Nuffield children would,on average,have acquired more multiple discriminations,concepts, and principles relevant to later science learning than their A.A.A.S. counterparts. Now,if I am correct,and it is just speculation at this moment,the result I anticipate would be in the direction of confirming Gagne's system but discrediting its particular form and quality of application in the A.A.A.S. curriculum.

Similarly,one would be unlikely,or at least unwise,to discredit McLeish's intuition that,among other things,role-playing has peculiar advantages for the development of social competencies from observation of the use of "role-playing" by scientologists.

……

The synopsis of this paper indicated that I would conclude by advancing some broad principles linking learning experiences to pupil outcomes. Time does not permit this - either now in delivery, or,retrospectively,in preparation. I hasten to provide a rationalization for this state of affairs by adopting a popular piece of educando, namely that the teacher should studiously avoid doing the pupil's thinking for him.

However,I would like to conclude on a point which is not unconnected with what I have avoided doing.

It seems inevitable to me that some clarrification,derivation, and selection of objectives of a curriculum must be accomplished before any serious attention can be given to consideration of other matters including that of the clarification,derivation,and selection of learning experiences calculated to bring these objectives to fruition.

I am by no means convinced, even if the same set of objectives is eventually selected for all children, that these objectives will be achieved uniformly or will necessarily be best approximated by a common set of learning experiences. The basis for this position derives essentially from my consideration of the problem of individual differences in learning.

Completely common objectives and completely common learning experiences constitute a closed system with control effectively vested in the materials conveying the learning experiences.

I am willing to accept that at senior secondary levels and higher and in the present state of our society that more systematic disciplined scientific studies are demanded. Given that it can be said that the senior student retains some measure of control through choosing to study a particular science or sciences or not, the curricula of these sciences at these levels must, I believe, be relatively closed systems - that is, with relatively fixed objectives and relatively uniform sets of learning experiences. (This is not to say that the objectives and learning experiences prevalent today at senior levels are not open to criticism).

In science education at the junior secondary level and certainly at the primary level, I am much more inclined to think that a more open system is desirable, with at least some choice in the range of objectives and the level of achievement acquired in their pursuit and considerably more choice in the means of pursuing these objectives.

If this is accepted, it would seem a wise strategy for A.S.E.P. to produce materials embodying these choices. One essential feature of the materials should be that they, together with other experience, provide learning experiences for the teacher so that the teacher understands the basis of the pupil's learning. If the teacher so learns, he will have earned the right or confirmed the right to even greater freedom of choice and independent and responsible teaching.

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## APPENDIX I

## CLASSIFICATION OF VARIABLES AFFECTING THE EDUCABILITY OF THE CHILD

### I : Some Variables within the Child

A. Genetically determined

- (i) probably minimally affected if at all by what has happened to the child since conception
  - (a) sex
  - (b) age
  - (c) some physical characteristics
- (ii) subject to modification since conception and/or birth
  - (a) some physical characteristics
  - (b) some physiological characteristics related to health
- (iii) subject to modification by environmental interaction
  - (a) basic intellectual capacity
  - (b) some special abilities
  - (c) some physical and physiological characteristics
  - (d) personality (???)
  - (e) temperament (??)

B. Socially determined or influenced

- (i) common to all or most members of a particular society or culture
  - (a) language
  - (b) basic values
  - (c) some patterns of social behaviour vis-a-vis people
- (ii) unique to the individual child or relatively small groups of children
  - (a) nutrition and general health
  - (b) deprivation and/or disadvantage
  - (c) previous learning pattern

### II : Some Variables External to the Child

A. System structure variables

- (i) structure of the school system relative to the social system and values system
- (ii) curriculum
- (iii) characteristics of the individual school and individual classroom

## APPENDIX I (Contd.)

B. Instructional variables

(i) teacher training and experience

(ii) teacher 'personality'

(iii) methods and materials

III : Value Pattern Variables

A. The value patterns and attitudes of the social system.

B. Values and attitudes of the family

(i) vis-a-vis the child

(ii) vis-a-vis the school system

C. Values and attitudes of significant peer groups

(i) vis-a-vis the child

(ii) vis-a-vis the school system

# APPENDIX II

## FIVE AREAS OF LEARNING ACCORDING TO MCLEISH

### 1. Objective Information

Information is used here in a non-technical sense to signify material which can be communicated and reproduced,especially material which has been encoded in some sense so that it is in a standardized and impersonal form. Usually this material is verbal in character,but it may consist of other signs and symbols (e.g. plans,maps,graphs, formulae,etc.)

### 2. Technical Skill

In the most general terms,a technique is the art of converting a material or thing into something else that we need,want,or can sell - usually with the help of instruments or tools. Techniques may be of a reflective character (i.e. their underlying principles are understood) or they may be non-reflective (traditional,empirical,rule-of-thumb). Itis useful to distinguish between technical skills which involve only instrumental activities (making something for use) and those which involve expressive activities (i.e.,the product embodies feeling and value in some significant way). In the latter case,the person using the skill will normally be deeply involved emotionally in the activity.

### 3. Social Competence

In an industrial society,it is relatively easy to confuse social and technical skills. But there is an essential difference between skills with materials and skills involving the human being. In a human relationship,expectations are mutual or two-sided. The technician has expectations about how his material will react to "handling", and adapts his behaviour accordingly. The material does not have any expectations of the technician;its reactions are limited to those characteristic of the class to which it belongs. Human reactions are less predictable and problems of an ethical nature arise which are irrelevant in other contexts. We can also make a distinction between a personal relationship and a social one. The social relationship is more connected with expert knowledge and technical skill than is a personal one. Social relationships are guided by public rules which apply to defined social positions,rather than to people as unique individuals. Where a person effectively interacts with others in relation to his social position,in accordance with the rules,we say he is competent. In a personal relationship,there is a greater element of spontaneity involved,and the rules of social discourse are more liable to be "bent" depending on the closeness of the relationship.

### 4. Personal Acceptability

This seems to be more closely linked with the inner qualities of temperament,personality,and character than the other three levels. Warmth,integrity,courage,humour,faith play a large part in personal acceptability. These qualities are often thought of as linked to some "self" lying behind knowledge and technical skill and even social competence.

APPENDIX II (Contd.)

5. Self-insight

This is related to the ability to understand who one is, what one has been, and what future possibilities appear tobe open. It is very close to feelings and values. In a phrase, it involves openness to the whole of one's experience.

# APPENDIX III

## DESCRIPTIVE DEFINITIONS OF SOME SELECTED TEACHING METHODS ACCORDING TO MCLEISH

### Demonstration

The demonstrator performs some operation exemplifying a phenomenon or skill.

### Controlled Discussion ("Socratic" method)

Commonly known as "teaching" when indulged in in schools. The teacher has carefully prepared materials principally in the form of questions which are designed to draw out,on the basis of previous experience,the required data from students. The students may raise questions or comment,but the general direction is under the strict control of the teacher.

### Critiques

Where student work or performance is evaluated by an expert during or shortly following an "on-the-job" functioning by the student. Not infrequently,other students are present as a group.

### Simulation Exercise

A real life situation is duplicated in its essential features in the form perhaps of a "game" or a problem which must be solved within a given time. Participants adopt the roles or status appropriate.

### The Syndicate Method

The class group is divided into sections which work on the same, or related,problems in competition with each other. Their solutions are presented to the full group for discussion and critical appraisal.

### Counselling

Students go voluntarily with their individual (academic or personal) problems in a regularized way to a tutor or counsellor who has at least a minimal training in counselling techniques.

## APPENDIX IV

## TEACHING METHODS IN RELATION TO FUNCTION ACCORDING TO MCLEISH

1. Objective Information

   Who : the lecturer, the pedagogue, the tutor.

   How : question-and-answer technique, set assignments from a text-book. teaching-machines, lectures, observational search, fact-finding research, training in use of reference works.

2. Technical Skill

   Who : the instructor, the coach, the trainer, the tutor.

   How : drill, exercises, practical work under supervision, demonstration, analysis, model-building.

3. Social Competence

   Who : the tutor, the exemplar

   How : supervised social experience, information about social rules (moral training), parables, case discussion, guided discussion, role-playing.

4. Personal Acceptability

   Who : the tutor, the friend, the therapist

   How : informal discussion, the interview, tape-recording, analysis of experience, psych-drama.

5. Self-insight

   Who : the tutor, the therapist, doctor, priest

   How : as in 4.

# APPENDIX V

## SUMMARY DESCRIPTIONS OF EIGHT TYPES OF LEARNING AND OF THE NECESSARY CONDITIONS FOR LEARNING ACCORDING TO GAGNE WITH SOME EXAMPLES

### Signal Learning

Description : The individual learns to make a general, diffuse response to a signal. This is the classical conditioned response of Pavlov.

Conditions : Present signalling stimulus and unconditioned stimulus in close proximity and in that order. Arrange repetition if necessary.

Example : ex-student returns to school science laboratory and teacher and experiences a warm glow of well-being, smiles, feels relaxed, etc., or, alternatively, feels cold, shivers, is uncomfortable, fidgets, etc.

### Stimulus-response Learning

Description : The learner acquires a precise response to a discriminated stimulus. What is learned is a connection (Thorndike), or a discriminated operant (Skinner), sometimes called an instrumental response (Kimble).

Conditions : Provide repetition of the stimulus response connection, applying reinforcement immediately.

Example : The student learns to pronounce new words (Kekulé, Tetrahedron, Molybdenum, etc.).

### Chaining

Description : What is acquired is a chain of stimulus-response connections.

Conditions : Reinstate stimulus-response connections in the proper order, either by starting with the terminal connection and working backwards, or by using prompts. Reinforcement of the terminal connection and repetition are necessary.

Example : The student learns to operate an instrument, e.g. burette or microscope, correctly, smoothly, and "automatically"

### Verbal Association

Description : Verbal association is the learning of chains that are verbal. Basically the conditions resemble those for the learning of other chains (motor), but the presence of language in the human being makes this a special type because internal connections may be selected from the individual's previously learned repertoire of language.

Conditions : Reinstate verbal connections in the proper order, including mediating or coding connections. Repetition and reinforcement of the terminal connection are necessary. For longer chains, external prompts may be needed to provide sequence cues.

Example : Student learns the order in which elements appear in groups and series of the periodic classification.

## APPENDIX V (Contd.)

### Multiple Discrimination

Description : The individual learns to make n different identifying responses to as many different stimuli,which may resemble each other in their characteristics to a greater or lesser degree. Although there are eventually n correct stimulus-response connections,the connections tend to interfere with each other's retention.

Conditions : Present stimuli in small subset groupings emphasizing distinctiveness. Repetition and reinforcement are necessary.

Example : The mineralogy student learns to identify by name any one of a set of minerals. The anatomy student learns to identify by name any one of the bones of the human skeleton.

### Concept Learning

Description : The learner acquires a capability of making a common response to a class of stimuli possessing some common characteristic(s) but which may vary widely in other characteristics. He is able to make a response which identifies a whole class of stimuli.

Conditions : Present a variety of stimuli that represent the concept class,each stimulus having a learned connection with the common response identifying the concept. Verify by presenting stimuli including members of the concept class. If concept not acquired,continue presenting varied stimuli as initially.

Example : The student learns to identify a "tetrahedral structure" in any one of a variety of diverse stimuli otherwise exhibiting this structure,e.g. solid tetrahedron, cluster of four spheres,"four points equally spaced on the surface of a sphere",etc.)

### Principle Learning

Description : In simplest terms,a principle is a chain of two or more concepts. It functions to control behaviour in the manner suggested by a more general logical rule of which the particular principle is an example. For example,"Plants grow" - If it is a plant,then it grows (or has grown). Note that a principle is not the same as a verbal association. The test of acquisition of a principle is not to ask the learner to produce the verbal rule statement corresponding to the principle.

Conditions : Inform the learner of the performance to be expected. Invoke recall of component concepts by verbal instructions. Make verbal statement of the principle. Verify by requiring the learner to make a performance demonstration of the principle - e.g. say "Show me" - in one or more particular instances of the principle.

Example : The student learns Boyle's Law such that he can correctly demonstrate the consequences for pressure of a change in volume and vice versa in one or more instances.

Problem Solving

Description : Problem solving is a kind of learning that requires the internal events usually called constructive thinking ( and by some is implicated in "discovery" and "creativity"). Two or more previously acquired principles are somehow combined to produce a new capability that can be shown to depend on a higher-order principle logically derivative on the previously acquired principles.

Conditions : Inform the learner of the performance to be expected. Invoke recall of previously learned concepts or principles. Provide verbal guidance that directs thinking, but that does not state the higher-order principle being attained.

Example : A student with knowledge (previously acquired principles) of the Gas Laws and knowledge (previously acquired principle)that atmospheric pressure decreases with altitude is able to predict certain things that are likely to happen to an initially ascending helium balloon.

# ASEP CONFERENCE

## SYNDICATE SESSION - TUESDAY

The discussion in this session will be concerned with criteria for materials development, which arise from and are consistent with the stated purposes, aim and rationale for the Project and which take into account what is known about teachers, children, schools and the learning process. It is expected that the outcome of this discussion will be a set of tentative guidelines for materials development.

It would assist the organization of the products of the discussion if each syndicate uses the headings set out below for both the discussion and the syndicate reports. Additional headings considered to be of equal or greater importance should be added. In discussing each heading, syndicates should not limit the range of discussion to recommendations made in the paper.

1. The extent to which the effectiveness of the materials should depend on teacher organization of the learning situation
   (Recommendations 1, 3, 13, 15, 18, 22)

2. The differences among children for which the materials should provide
   (Recommendations 2, 12, 15, 16, 19)

3. Criteria for selection of the "science-linked" experiences that should constitute the subject matter of the materials
   (Recommendation 19)

TUESDAY (continued)

4. The learning procedures that should be built into the materials
(Recommendations 2-12, 14)

5. The physical format of the materials
(Recommendations 20-22)

## QUESTIONS FROM GROUPS FOR TUESDAY SYNDICATE SESSIONS

The questions directed at materials development from the Sunday evening group meetings are reproduced below. They are listed under five headings which correspond roughly to the areas for discussion decided by the executive prior to the conference. It would be helpful to those eventually having to establish order and coherence from the afternoon's deliberations, if these questions could be discussed (if the syndicates wish to discuss them) within the five pre-established areas.

### Area 1

1 To what extent will teacher and pupil opinion influence the design of materials?

2 To what extent should we cater for the traditional teacher and his techniques; should the materials instead be truly experimental and innovative?

3 Will the Project, set out, to produce materials, to provide a total course?

4 What percentage of the materials, will be teacher-orientated materials?

5 To what extent will ASEP produce materials, to meet different teacher emphases and interests?

6 Should there be different sets of materials to meet the same set of objectives?

### Area 2

1 To what extent will audio-visual materials act as teaching material rather than as a stimulus for learning?

2 How can the materials developed cater for the diversity of primary school experience?

3 How do we cater for individual differences?
Pupils and teachers.

4 What are the minimal entry requirements for pupils entering the Project from primary systems of education?

### Area 3

1 What is the role of materials that exist already?

2 Should the curriculum materials be structured around, certain powerful ideas, or should they be more general?

3 To what extent will the Project be complete, that is to what extent shall the materials designed incorporate existing materials?

4 To what extent should the study of social behaviour be a part of science teaching?

### Area 4

1 To what extent should content grow independently from problem-solving and vice versa?

2 What is the primary source of information, for the pupils, the teacher, or the materials?

3 What is the degree to which the materials are to be directed as against open ended?

4 Are the materials to be hierarchical in structure? (prerequisites)

## Area 5

1 Should we involve commercial publishers on our terms?

2 Should the design of materials be influenced by the cost to schools?

# DISCUSSION QUESTIONS

1. If A.S.E.P. is to continue to give attention to individual differences in learning as did J.S.S.P., which one or more in combination of Cronbach's patterns of adaptation might be used ? For what reasons ? Are there any other possible patterns of adaptation to individual differences in learning ?

2. How useful is Gagne's eight types of learning and their prerequisite conditions likely to be :-

   a. in planning the project
   b. in developing materials
   c. in producing evaluation materials
   d. as subject matter for teacher education ?

3. Ditto 2 but instead of Gagne insert McLeish, Bloom, Krathwohl, French, Havighurst, Guilford, etc.

4. Are there any one or more of McLeish's five areas that you would automatically exclude from consideration in A.S.E.P. developments ?

5. Are there any one or more of McLeish's many modes of instruction that you would automatically exclude from consideration in A.S.E.P. developments ?

SYNDICATES TUES
MATERIALS

Room 2

## AMENDED RECOMMENDATIONS

2. All materials must take into account the three Piagetian stages of development in children.

13. (Additional sentence)
Sufficient guidance should also be given to teachers as to the strategies likely to achieve these outcomes.

16. Materials should be produced which allow for three main levels of reading ability - Reading Grades 6-7, 8-9, and 10-11, with some supplementary materials at Grades 4-5 and 12-13 levels. Usually any one portion of materials should be written at one reading level only but several reading levels could be represented in a set of materials.

19. The subject matter of the Project should be concerned with attitudes of students, manipulation of equipment and materials, science content, environmental applications of science, the extension of knowledge, the use of science processes, and should be consistent with the structure of scientific knowledge. Project material related to the pupil's environment should predominate. (See Rec.3)

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Discussion questions based on Dr.Turner's paper 20/1/70 -

NOT DISCUSSED.

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| | | | |
|---|---|---|---|
| The effectiveness of the materials should not, if possible, depend on teacher organization.<br>The project should provide a bank of materials, to allow inexperienced teachers to grow, while at the same time, allow the imaginative and creative teacher to participate in the development of his own classroom situation.<br>It should be realised that the teacher is a valuable and scarce commodity in the community. The project should be wary of increasing the demands both physical and otherwise it places on the classroom teacher. | The effectiveness of the materials depend on the extent to which the teacher can implement and exemplify the strategies and attitudes of the project and hence sufficient guidance should be given to allow maximum effectivenss.<br>Recommendations 1, 3, 15, 18, 22 accepted.<br>Recommendation 13 amended. | The physical organization and preparation required to use the materials should be as simple as possible.<br>Figures on the qualifications and experience of teachers of junior secondary science, and predictions for the future, should be ascertained for all States.<br>The project should assume that teachers will not be fully qualified - most will have no specific science training, and a significant proportion will have no teacher training.<br>Nevertheless, many of these teachers will be enthusiastic, and every effort should be made to sustain this enthusiasm and involvement. The use of teacher consultants is excellent.<br>The teacher is a vital part of the system, and should always be given an opportunity to transmit his experience and enthusiasm to the pupils. With each piece of material produced, the role and tasks expected of the teacher should be specified. | The materials should depend on teacher organization only so far as it is consistent with an approach which allows a maximum of direct interaction between the children and the materials.<br>Recommendations 1, 3, 13, 15, 18, 22 are approved. It is emphasized that, with respect to recommendation 22, prerequisites and sequence are likely to be more important in later years. |

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 2. The design of the project materials should take account of the fact that individual student differences do exist, and should be such as to accomodate, both heterogeneous grouping and forms of tracking or streaming, which may be practised in schools. Materials should be developed, to take into account, compensating differences such as:-<br>- language problems experienced by new Australian children<br>- socio-economic problems in slum and industrial areas<br>- reading ability etc. | Recommended differences to be catered for: Reading ability, communication bothorally and written, comprehension, home background school background, interests, attitudes, motor skills, stage of maturation (including several variables).<br>Recommendations12,15, accepted.<br>Recommendations 2, 16, 19 amended. | Provision should be made for differences in language abilities. The project should assume minimum abilities in mathematics, but should teach any further mathematical skills as and when they are required.<br>Any single unit would probably tend to run through the 3 "Stages", but taking the course as a whole, there would probably be greater emphasis in the first 2 years of the course on the concrete (Stage 1), and a stronger emphasis on formal reasoning in the later years. | The relevant recommenda<br>should read as follows:<br>2.Materials should be<br>taking into account th<br>stages of development<br>12.Motivation for lear<br>may be brought about by<br>(a)student participatio<br>things as group problem<br>and the determination<br>areas of interest to th<br>they wish to pursue.<br>(b)variety within and<br>the types of materials<br>(c)the successful achi<br>the series of learning<br>they undertake.<br>The project should exp<br>use of all of these th<br>possible means of moti<br>15.The materials shoul<br>mainly for the science<br>of children who do not<br>with the study of scie<br>grade 10.<br>16.As written plus the<br>The project should inv<br>ways of alleviating re<br>disabilities, includin<br>emphasis on means of c<br>tion other than the pr<br>word. Professional ad<br>cerning presentation i<br>ing materials should b |

Ref. Prof.Fensham:-

The compensating principle that the child has a right to receive compensation in learning for inhibiting factors over which he has no control. (Turner)

In line with this principle the project should set out to prepare learning materials which will help some major groupings of children to overcome their handicaps and so achieve the same outcomes as more advantaged. This attempt will no doubt only be possible to a limited extent and not all parts of the course would necessarily have such compensatory materials. Priority for this material would logically seem to be in the early stages. Some groups who can be identified in Australian schools are those from migrant and those from certain socio-economic families. Associated with this attempt at compensatory education attention should be given to the parent-pupil and parent-teacher communication concerning the course. Science has advantages that should make compensatory materials possible. One way of doing this would seem to be the avoidance of dependence on literate abilities and the encouragement of oral responses about the child's experience of scientific situations.

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| The group felt that this statement needed further discussion at a full plenary session. Some of the criteria on which material should be selected are:<br>- Processes of science.<br>- Development of social skills among children.<br>- Content should be directed towards achieving some structure of knowledge.<br>- Personal development of the student (independence creativity).<br>- Relevance to a child's interest and environment.<br>- Maintenance of the child's interest.<br>- Appreciation of the way in which man has changed his environment. | Delete 'science-linked in heading.<br>Recommendation 19 amended (see under Heading 2).<br>Additional criteria recommended:-<br>(1)Consideration should be given to learning theories as criteria for selection of project materials.<br>(2)Materials should promote awareness of an integrated view of science i.e. an appreciation of how 'big ideas' provide man's environment.<br>(3)Materials should provide links with other areas of school studkes and community studies.<br>(4)Materials should transfer modes of enquiry to life situations.<br>(5)Psychological and social; when group learning or classroom situations or community interaction become matters of real concern.<br>(6)Some aspects of the materials should be concerned with developing a sense of grandeur of the universe, the creativity and fallibility of man and the universal nature of scientific study. | It was ruled that this matter would not be re-opened. - refer to plenary sessions on Monday. | Final selection should be based on pilot tests. |

Best Avialable

|  | Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|---|
| [illegible] | Not discussed. | Not discussed. | We agree with the recommendations. | We expect that learning procedures will be varied, and that they will be related to the objectives of the particular unit, and should as far as possible allow for individual differences in learning. |
| 8. | Not discussed. | Not discussed. | Modern printing methods should be investigated, with a view to producing very cheap expendable materials on low-cost paper.<br>A survey of the durability of various materials (paper, cards, booklets) in schools should be made.<br>Question<br>Area 5.4<br>Structure within a unit is necessary; sequential links between units should be as few as possible.<br>One member of the group disagrees with the statement that sequences among materials should be kept to a minimum. | These should be [illegible] |

Best Avialable

## TUESDAY EVENING - PLENARY SESSION

### Point 1

The Project should provide a bank of materials, to allow inexperienced teachers to grow, while at the same time allow the imaginative and creative teacher to participate in the development of his own classroom situation.

It should be realised that the teacher is a valuable and scarce commodity in the community. The Project should be vary of increasing the demands, both physical and otherwise, which it places on the teacher.

With each piece of material produced, the role and tasks expected of the teacher should be specified.

We recognise the importance of the teacher, one of whose roles it is to maximise the interaction between the child and the materials provided.

### Point 2

The design of the Project materials should take account of the fact that individual student differences do exist; and they should also be such as to accommodate both heterogenous grouping and forms of tracking or streaming which may be practised in schools.

Differences which we would recommend for consideration include: reading ability, communication - both oral and written, comprehension, home background, school background, interests, attitues, motor skills, and stage of maturation. (A further factor, on which there was not full agreement, was mathematical ability.)

[ **Rider:** We should register our concern about sections of the community which may need compensatory treatment. If this lies outside the practicable range of the Projet we suggest that the matter be passed on to the appropriate authority for action.]

[ **Ref.Sugg :** Motivation may also be brought about by studets succeeding in the series of learning tasks which they undertake.]

### Point 3

Discussion deferred until Thursday. The material broght forward will be incorporated in a paper to be presented by Dr. R.S. Vickery.

### Points 4 & 5

Insufficient material brought forward for valid discussion. The cost, durability and attractiveness of materials were entioned.

## WEDNESDAY JANUARY 21

The evaluation and service aspects of the Project

morning : two papers
afternoon : syndicate discussions
evening : plenary session

## ASEP GUIDELINES CONFERENCE

## "THE KINDS OF SERVICES AND EVALUATION PROCEDURES THAT COULD BE PROVIDED FOR IN THE AUSTRALIAN SCIENCE EDUCATION PROJECT"

### INTRODUCTION

I am told that one of the tasks of an evaluator is to provide answers to relevant questions. Probably the most fundamental question that should be answered in the context of this Guidelines Conference is the question "Why does the ASEP Project exist?". The question has many answers. There are political answers, economic answers, emotional answers, and answers based on expediency or even national prestige. Such answers need not concern us here, for they are part of the history which led to establishing the basic charter for the Project and its definition by the Committee of Management in their statement of the purposes of the Project.

What does concern us are the educational answers to the question 'Why does ASEP exist?'. We believe that the ASEP Project exists to bring about a change in the science education of the students in Grades 7-10 in Australian schools. We believe that the changes expected are improvements in present materials and practices, which of course implies that deficiences exist in the present materials and practices used in schools.

Over the past couple of days we have been talking about the changes we want in science education. In general, these discussions have related to the changes we want to bring about in students, what changes to expect, and what materials and instructional methods will be needed to bring these changes about.

In this paper the role of the Service side of the Project in the change process will be discussed. Some may say that a detailed discussion of at least the evaluation component of the service side is premature until a clear statement of aims has emerged, and materials have been developed to produce student outcomes in line with these aims. The case for this is strong if one believes that evaluation is separate from development. Certain evaluations and even certain services must be separated from development, but most of the evaluation and service to be performed by the Project, which it should be remembered is only funded to exist up to pre-publication stage, is part of development rather than separate from it.

In the early stages of the Project - and indeed for most of its funded period, the Service and Development functions will be closely interlocking endeavours with the one providing feedback and control for the other. Nor can any one person working on the Project see his role as just development or just evaluation or just teacher education. One group will come to depend on another to meet certain demands of the change process, and all groups will work together to bring about the desired change.

### THE ROLE OF THE SERVICE ASPECTS OF THE PROJECT

The Service side of the Project exists to ensure that Purpose 1 of the Project is fulfilled, namely, to ensure that the Development side can and does "develop instructional materials in science for use by teachers and pupils in Grades 7-10 in Australian schools".

Purposes 2-5, summarized briefly as the evaluation of current practices, the development of suitable instruments, the development of a teacher education program, and the establishment of a resource service, are essential if Purpose 1 is to be fulfilled.

The development of the materials and the servicing of them are synergic processes; however it is useful for purposes of discussion to separate the functions of the service area in the total change process. We see the functions of the service branch as being to:

1. produce (in a technical sense) the materials for change.
2. stimulate the change process among teachers.
3. monitor and describe the change process.
4. evaluate changes produced.

Function 1, the technical production of the materials, will not be discussed in any detail at this stage. We have a charter to produce materials to the pre-publication stage. We believe that for materials to be evaluated effectively in the trial stage, they need to be produced for this stage in a form which is as close as possible to their final published form. For this reason we intend producing trial materials of high quality. We have a personnel structure which will allow this, and we have initiated the procurement of suitable equipment to ensure that it can be done.

One other aspect of materials development where comment may be relevant at this Conference is on the cost of materials to schools, and how these may be paid for. Innovative materials can be expensive. Often they are sold as complete instructional packages rather than as individual texts to be bought by students. We want to produce materials that are of maximum usefulness to teachers and students. Yet we realise it does not matter how useful they are if schools and teachers are unable to purchase them because they are too expensive. At very least new ways of purchasing the materials quite different from the traditional may have to be explored.

The remaining three functions will be dealt with in some detail, to explain how these functions can fulfil the Service Purposes of the Project. Before discussing the four Purposes more specifically, I intend to examine some general aspects of the evaluation of curriculum development projects, and propose a model for the process suited to the particular demands of the ASEP program.

## THE TASK OF EVALUATION

At this point it seems important to establish what the Project understands by the term evaluation. We mean quite simply the gathering of relevant data so that valid judgments regarding the change process may be made. The terminology we are going to use derives from the work of Michael Scriven[1] and Robert Stake[2] who have helped to establish at least some common definitions in the field.

Three phases of operation can be identified in an evaluation program. The three are formative evaluation, summative evaluation and basic research.

## Formative evaluation

Formative evaluation is concerned with the improvement of the materials being developed. In this phase, the parts of the total program being developed are tried out in schools, instruments are developed to test whether the expected gains are being made, and improvements in the design of materials are suggested. The evaluator and the materials developer work closely together in this phase. The evaluator can help the materials developer translate his objectives into a testable form, or help with the restructuring of learning experiences shown to be unsuccessful in the trial stage.

## Summative evaluation

The summative phase of evaluation is designed to make some appraisal of the total package produced. This may be done by comparing the total package developed by one project with that developed by another on a number of criteria, or by appraising how closely the total package comes to fulfilling its stated aims. For summative evaluation, the evaluator needs to be fully conversant with the aims of the Project, understand what the materials are trying to do to children, and then, using tests developed in the formative phase and others which are congruent with the philosophy of the system, gather evidence on which to base judgments regarding the effectiveness of the program as a whole.

## Basic research

The basic research phase of evaluation uses the opportunity afforded by the Project to do basic research on various aspects of instruction, reading level, sequency of concepts, use of audio-visual aids, etc. Some examples of basic research that could be carried out quite easily along with the development of Project materials include:

1. determining the effect on concept formation and attainment of different ways of sequencing a unit of material
2. comparing outcomes by teaching the same material using different instructional methods
3. determining whether there is any relationship between teacher-held objectives and student achievement
4. finding what influence different instructional methods have on retention of concepts

## Internal and external evaluation

Evaluation in each of the three areas formative, summative, and Basic research, may be either internal (i.e. carried out by Project personnel) or external (i.e. carried out by persons or organizations outside the Project). We believe that from the structure of the Project and the way it has been set up, most evaluation from within the Project by Project staff will be of the formative kind, and intimately involved in the development process. We believe that we can establish base-line data for future summative evaluation, and establish some criteria for it, but summative evaluation of the total program is outside the funding of the program as it is now established, and will have to be done largely by persons external to it. Likewise, with basic research, we think that the Project can supply the opportunities and resources for outsiders to do some of this, but it does not have the personnel nor the funding to be actively involved in this endeavor - especially since this could mean diversion of resources away from the prime aim of developing materials for classroom use.

## Summary of the evaluation task

If we look on evaluation as being gathering information on the basis of which judgments may be made, the three areas of evaluation discussed above require three kinds of information to be gathered, if a complete and comprehensive evaluation of a program is to be attempted:

1. information from feed-back on materials developed which will lead to further revision,
   Such information may come from trial teachers in the field, State Advisory Committees, scientists reading the materials etc. This is the information gathered in the formative evaluation.

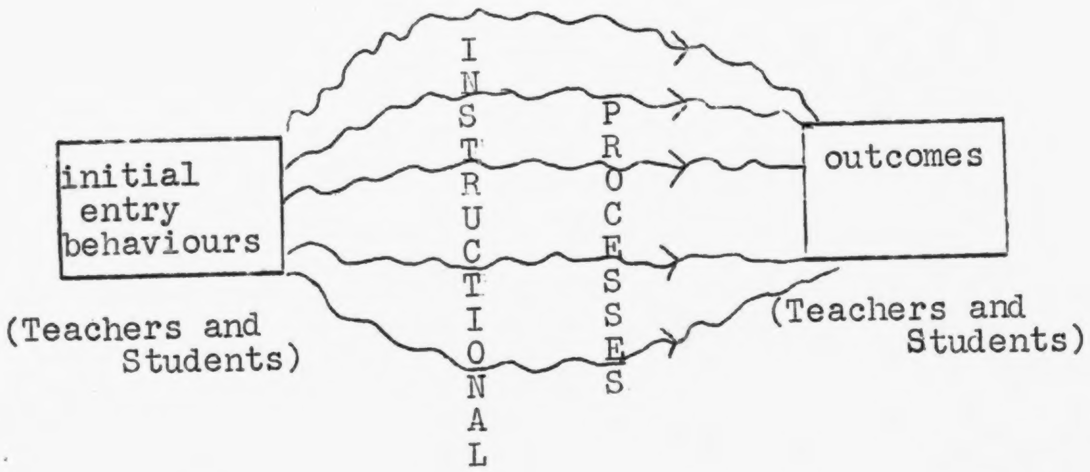
2. information from the trials and from post-publication use which would help schools decide whether they want to adopt the materials we produce,
   This is the summative evaluation information which gives objective information on which to base adoption decisions.

3. information from basic research which adds to the total knowledge of the field.
   This information can be used either to support or refute some of the positions taken by the Project on learning and instruction, for example.

From the funding that we have available, most of our evaluation effort will be directed at gathering information relevant to formative evaluation. Indeed from preliminary cost analysis, we are going to have little resource to go beyond the development of student tests and coping with feed-back. We will be virtually unable to do much in the way of summative evaluation and basic research. These will in general have to be performed by persons outside the Project but, of course, working in co-operation with it.

## Data gathering

The gathering of information, whether for formative evaluation, summative evaluation, or basic research should be at three points in the operation of a particular program. Initially, it is required to establish what the conditions are prior to trial of the materials. These are the entry behaviours which teachers and students have before the program is introduced. Finally, there are the exit behaviours which teachers and students have after going through the program. Both these sets of behaviours are relatively stable things which are subject to test often using the pencil and paper kind. Between these two comes the dynamic process where the teacher works with his group of students using some instructional method in an attempt to achieve desired outcomes.



Traditionally when evaluating we have only monitored the student outcomes. We have determined the abilities achievements and attitudes of the pupils at the end of the program, occasionally we have determined them at the beginning, but rarely have we taken entry behaviour into account in describing what changes have occurred or in designing the instructional sequence. Even more rarely have we attempted to describe the instructional processes in the classroom, or the entry and exit behaviours of teachers using the program. Unfortunately, from the resources we have available, it is unlikely that the ASEP program will be able to do much more than determine student achievement and outcomes.

In an ideal case, or, considering all aspects of internal and external data-gathering at the three stages outlined above as being possible, how could an evaluation program be set up to ensure that valid judgments regarding the Project could be made.?

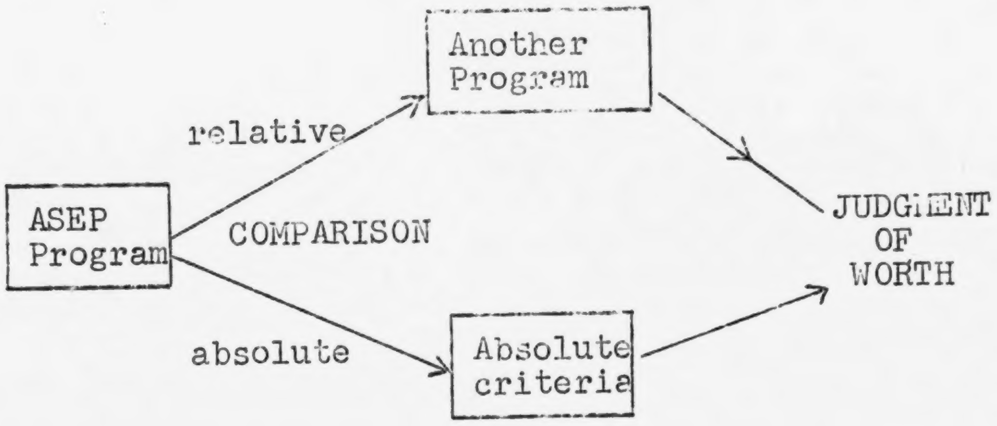
Comparison with another program

Judgments could be made from relative comparisons with another program. It could be done by comparing what happens to children and teachers when they go through the ASEP program with what happens when they go through another program. Some comparison programs could either be the ones already being used in the States, or a new program introduced from overseas (e.g. Nuffield) to parallel the introduction of our own.

Comparison with absolute standards

Judgments could also be made on the basis of comparisons with certain standards of excellence proposed as criteria for success by the developers of the Project materials. In this evaluation, observations are made to help decide how closely the intents of the program are actually accomplished. Or, given certain entry behaviours, it is logical that if we instruct in a certain way, we should get certain expected outcomes. The job of the evaluator is to test the logic of the sequence of instruction from the empirical evidence.

These two methods of comparison give two sets of reference points on which judgments regarding the program may be based. Some evaluators propose the one, some the other. Valuable information may be gained from both.



In the Project we will be able to make formative comparisons using both techniques, but not summative comparisons.

### Evaluative judgments to be made.

Hurd has identified three main areas in which valid judgments concerning Project materials need to be made. Again, one may apply either absolute criteria, or relative criteria based on the materials and methods of another program to aid this judgment.

### Content validity

Is the content taught valid? The opinions of scientists in the field are essential to assure this in the materials. It is much more difficult to ensure the content validity of what the teacher actually teaches.

### Pedagogical validity

Are the materials teachable in their present form? This can only be assured if the materials are tried in a wide range of educational situations. Often materials valid in one teaching situation are quite invalid in another.

### Social and Philosophical validity

Are the positions we take in our rationale for the Project borne out in the materials we develop and in the ways they are used in the classroom? Is the philosophy of the teachers congruent with the philosphy of the materials?

Some answers to these validity questions are part of the formative evaluation, and will be a significant segment of our evaluation effort. A major difficulty will be to transfer the validity of the materials without significant loss to the teachers using them.

### EVALUATION AND OTHER PROJECTS

A general theoretical rationale for the evaluation of a materials development project has been presented, and the extent to which ASEP believes it can carry out the total range of possibilities has been indicated. We think the structure is sound, and it may even appear simple to do. Programs of evaluation have not been the strong points of many of the previous curriculum development projects. Although we have a structure for the evaluation process, we do not have many instruments available to gather data in areas outside cognitive outcomes of students.

There are many tests available for measuring achievement, and sound guidelines exist for developing tests to parallel the materials prepared by the Project. There are fewer for determining student attitudes, affective changes, or skills development.

In the area of determining changes in teacher attitude or ability, or in the area of describing objectively the instructional process, much of what exists is highly experimental. We hope in the Project to examine some of these instruments already developed, and perhaps modify and adopt them for our own use. We will also explore some alternatives to the traditional pencil and paper tests, but the extent to which this can be done will depend on our resources. Our first priority is to develop essential pencil and paper tests for use with the materials.

The ASEP Project is in many ways unique. It has planned for a system of evaluation to parallel and even integrate with the development phase of the operation. For many other projects, evaluation has been of the intuitive kind, or by making comparisons with students in other programs on a limited number of outcomes. Such evaluation has been of the "That's interesting" kind, having little effect on what had been developed or on what was done in schools.

Welch[4] makes an interesting analysis of the evaluations carried out in 46 science curriculum projects reported in the International Clearinghouse Report[5]. Of this group, twentyseven carried out formative evaluation, six carried out formative and summative, two carried out formative, summative and basic research, while eleven carried out no ~~research~~ evaluation at all. Thus complete evaluation in the terms outlined earlier, is a fairly rare thing in science education research.

It is interesting for us to look at the kinds of formative evaluation activity carried out by the projects investigated by Welch[4]:

| Kind of activity | Number of projects |
|---|---|
| Teacher reports (written & verbal) | 26 |
| Classroom visitation | 15 |
| Student interview and discussion | 9 |
| Questionnaires | 7 |
| Test results | 4 |
| Video tapes of classes | 3 |
| Professional view of produced materials | 2 |

We are optimistic that we can incorporate each of these methods in our evaluation. We will be relying heavily on teacher reports and classroom visitation for the major part of our feed-back, but questionnaires and video and audio tapes of classes may well assume importance to gain feed-back quickly from teachers in distant areas.

The evaluation instruments used by the various projects show some variety, yet even though the list looks extensive, only eight projects reported any summative evaluation, and only 13 of 46 projects showed any evidence of success in achieving stated objectives.

| Instrument used | Number of projects |
|---|---|
| Project-developed achievement tests | 20 |
| Standardized achievement tests | 10 |
| Questionnaires | 7 |
| Project-developed cognitive tests | 7 |
| Test on Understanding Science (TOUS) | 6 |
| Attitude measures | 5 |
| Interest measures | 3 |
| Critical thinking or reasoning tests | 2 |
| Science process measures | 2 |
| Classroom climate inventory | 1 |

Again, as a Project, we would like to use instruments of the kinds outlined above. The priorities as we see them in the project, are approximately in the order:Project-developed achievement tests, standardized achievement tests if available, attitude and interest measures, science process measures, a classroom description measures, and questionnaires. And all of these tests, including those developed, and those adopted will be used to serve formative evaluation.

There is a danger in thinking that because we have a flag of evaluation attached firmly to the masthead, the problems of the Project will all be solved. It is one thing to conceptualize the task of evaluation, it is quite another to carry it out. Unlike the development of materials in education, there are very few precedents, and very little experience available.

We hope we can within the Project, cope with most of the formative evaluation, and perhaps where necessary devise tests and descriptive instruments which can be used in some future summative evaluation. We do not have the resources to go much beyond this, and we will have to rely on external evaluators to extend what we do.

It may be asked what benefits should accrue from a comprehensive program of evaluation within the ASEP program. At very least it should monitor the development and dissemination phases of the Project so that those aspects requiring revision are known before irrevocable decisions are made concerning them. It should provide evidence of what changes occur in certain school situations, and what changes to expect if the program is applied to others. It will not give all the answers to all the questions, but it may give some information regarding a few.

## EVALUATION OF CURRENT PRACTICES IN AUSTRALIAN SCHOOLS

Purpose 2 states that the project should "carry out such evaluation of current practices in a cross-section of Australian schools as is necessary to ensure that Project materials are tried in a variety of situations where the characteristics of the school, teachers, and students have been adequately described".

There is a strong case for saying that Purpose 2 should be fulfilled before any of the others. The argument goes that it is impossible to develop materials without first knowing what kinds of schools, students, and teachers are going to be using them. We believe, however, that we are not developing materials to serve existing conditions, rather,we are developing materials to change existing conditions. We believe we can have a model for change which can exist outside specific knowledge of schools as they are, and be based on the intuitive understanding of the developers of conditions as they exist.

In this model, what we want to discover is how these schools, these teachers and these students change when these materials are used, rather than the alternative of designing specific materials to change children in specific schools in specific ways. Because of the diversity of schools, students, and teachers, and the Project timetable, the second is impractical.

In the model presented, we can be gathering base-line data about teachers and students in trial schools while the first group of trial materials is being developed. We hope to gather the data from a cross-section of Australian schools in different localities in all the States. It will help us describe what changes do occur in students and teachers when the materials are used, and what changes are needed in administration or facilities for the materials to be most effective.

To help in our descriptions, data on the following could be gathered:

1. physical facilities for science in the school
2. administrative structure
3. perceptions of teachers regarding science and science education
4. attitudes of teachers to their students and to science
5. teachers' understanding of science education.
6. instructional methods
7. student characteristics - including their understanding of the scientific enterprise.

We believe the extensive gathering of baseline data for example, from a random sample of teachers, is too great for our resources. For this to be done thoroughly would require the co-operation of research branches of education departments, universities, and teachers' colleges. We believe this co-operation is essential if a complete summative evaluation of the Project is eventually to be done. We intend only to obtain limited data to evaluate changes in the trial situation.

## THE PRODUCTION OF SUITABLE EVALUATIVE AND DESCRIPTIVE INSTRUMENTS

As has been pointed out in the general discussion, evaluation is much more than achievement testing, although for many curriculum projects this is all that has been done. The development of suitable achievement tests is a key aspect of the evaluation program, however, and much of our effort will be directed to developing them. In fact, with an evaluation staff of three and a development staff of sixteen they would probably do little else. This situation will be relieved by some of the development staff and some outsiders also developing tests.

We believe that achievement tests are best devised by writing clear descriptions of desired learner behaviours written as objectives. These objectives should be written for at least two levels; one directed to the teacher, and the other for the students and the achievement tests designed should reflect these objectives. This is a difficult and time-consuming task, and the extent to which it can be achieved is likely to be disappointing with the time and resources available.

We believe two kinds of tests ought be developed. The first is designed to test whether students have attained the 'lesser learnings'(for want of a better term) that all students are expected to get from a particular learning sequence. The AAAS concept of ninety percent of the students achieving ninety percent of the expected behaviours is one that could be modified here. The second kind of test will be to attempt to assess the 'greater learnings'expected from a particular learning sequence. Here higher level cognitive skills may be tested. These two types of tests are designed to provide information on the success of individual students in attaining stated objectives.

We also wish to evaluate more subtle changes in attitude, interest, understanding of science, to see whether some of the long range objectives have been attained. Such tests are time consuming to construct, and the best we can do within the Project is to modify for our purposes some already in existence.

The pattern for developing tests of the pen and paper kind is well established, and the Australian Council for Educational Research Test Development Centre will be an extremely valuable resource. It is unlikely that in the developmental years we will be able to standardize the tests, and there is some doubt whether such an effort is worth while at this stage.

We intend to try out the tests developed in parallel with the materials so that the tests can be checked for difficulty level, over simplification, reading level, State bias. The method of developing tests as outlined by Grobman[6], with grids of objectives and activities will be used. The path of developing objective tests in Australia is well-worn, but we do hope to try a few innovations with practical skills, attitudes, and non pencil and paper tests.

Several tests already in existence could be modified if necessary for use with the Project. Test on Understanding Science, of Cooley & Klopfer, Watson Glaser Test of Critical Thinking, Cooley and Reed. "Science Activity Inventory" of science interests, and the Welch Science Process Test are a few that have been used in other projects. The area specialist for Evaluation has begun collecting test instruments which may be suitable in the Project evaluation.

We will also develop a questionnaire technique for teachers and students in the trial situation to help the feed-back of findings from the trials. We believe that the questionnaire is only one of several ways of gathering information from the classroom. Visits by writers and others, structured and unstructured recorded interviews, with teachers and students, and structured observations of classroom procedures, are all techniques which will be tried and developed.

We believe that video and audio tape recorders are important tools in monitoring the dynamic processes occurring in the classroom. The description of these dynamic processes is an area too often omitted in other projects, and it could well be one which we will have to limit because of available time and finance. Yet we believe it to be important, and we hope some of this description can be done by persons external to the Project.

We would like to investigate social climate, for example, with the instrument developed by Flanders, or use some with a more cognitive focus as developed by Medley, Smith, and Taba.

These are described in Simon and Boyer's "Mirrors for Behaviour"[7] and Hyman's "Teaching - Vantage points for Study"[8]. Again the extent to which we can do this will be very limited.

We do believe, however, that until we can adequately describe the dynamic processes involved in instruction, our evaluation will be limited to describing only what changes occur, and now how these changes occur.

Most of the development of achievement tests will be done by Project staff, but we hope we can extend outside. We would welcome, for example, people interested in describing classroom processes, or developing attitude and interest tests designed to test expected outcomes to work with us. It may be possible, for people from Teachers' Colleges and Universities to come and work with the Project at various times during the year to develop an instrument and rationale for trying it. Many such instruments will have general applicability to subject areas outside science; and experience gained in working with the Project, and experience gained by the Project having outsiders working with it seem important interchanges to be encouraged.

## THE TEACHER EDUCATION PROGRAM

### A rationale

We believe that this aspect of the ASEP Project is going to be a key factor in the success of the materials used in schools. We believe that the evidence for this is so strong that unless significant and sufficient of our own resources, along with resources provided by the States through the inservice organizations already set up are devoted to it, the materials we develop will affect children little differently from materials already in existence.

Even where materials have been developed to try to make them "teacher free" - ISCS is an example - the materials worked very well with good teachers, but much less so with poor teachers. Many of the first generation projects - e.g. CHEM Study and PSSC, have now degenerated in many classrooms to being new words (updated content) taught by the old methods of teacher lecture.

Five general premises regarding teachers and teaching will now be stated, to act as a base for a proposed ASEP Teacher Education Program.

1. The most important variable in the classroom is the teacher.

Teachers are all different. They have their own peculiar teaching strengths and weaknesses. They must be helped to recognize their strengths and capitalize on them. They must be helped to identify their weaknesses and allow for them. We believe that different teachers can use the same materials in quite different ways - that this is innovative, professionally rewarding and should be encouraged. To deny the teacher his key role in the classrom destroys initiative, is professionally unrewarding, and should be discouraged.

We believe that we can identify good teachers, and describe what they do so that what they do may help others use the materials more effectively in the classroom. We also believe we can identify bad teachers in terms of the aims of the program, but more important, we believe that we can help all teachers identify for themselves how they are going with the program so that they can teach it more effectively.

2. Teachers can be helped to increase their knowledge of teaching, and their understanding of Project philosophy and aims.

We believe that knowledge of instruction, and what is possible using the materials will grow as the Project develops and teachers both in the trial phase and later, should grow with the Project. We believe this will only happen if there is a conscious effort on the part of the Project to educate teachers in the philosophy of the Project by personal contact and carefully designed learning situations.

3. Teachers know how to teach better than they do. The program can improve both knowledge and ability to narrow the gap.

There are many reasons why teachers do not teach science as well as they know how to. They may feel oppressed by the materials they are working with. They may be over-burdened with administrative duties. They may have limited facilities. We believe that teaching guides can be designed to help teachers in the organization of time, materials etc., and to organize their lesson sequences so that they can teach more effectively and be more satisfied with the job they are doing. We believe that it is as important for teachers to learn to evaluate themselves as it is for them to evaluate their students, and we must attempt to devise ways for this to be done.

4. The success of Project materials in the classroom depends as much on the teacher education program as it does on the materials developed.

A case for this has been stated earlier. There seems to be little point in introducing expensive new materials into classes where the teachers are unlikely to use them in ways sympathetic to the aims of the course. There is also a case for taking the extreme position that materials should not be used in schools unless the teachers have had a teacher education program or are at least undergoing one. In fact, an important area of trial could be to see what happens if the materials are used without adequate teacher education.

The idea of a 'conversion course' is not new, even though it is rarely insisted on in education. We did not expect pilots to convert from piston engines to jets without a conversion course, adequate test, and eventual certification. Yet we expect teachers, on their own initiative to change horses, or is it change from horses to cars, without so much as a few hours of advice. We believe, as with aircraft, simulated experiences can be devised to help in the educative process. This can be done using video tapes, projected visuals, micro-teaching, and other relevant experiences. Indeed, in the trial phase we could build up a series of 'critical incidents', described by teachers experiencing them in the teaching situation which can provide a source of information for our teacher education program.

5. The best way to help teachers use the materials creatively in the classroom is through first hand experience with them, helped by other teachers who have used them, and through being involved wherever possible in the development process.

We believe that teacher involvement is a key factor in any development process. If teachers are involved they are more likely to be constructively helpful and less likely to stand off and be destructively critical. We believe that this involvement can be aided by helping establish a team approach to teaching science in [illegible] schools, and a regional approach so that schools in close proximity can share their ideas.

We believe that opportunity should be given to teachers to contribute materials and ideas to the Project, and perhaps even write up learning experiences and tests in a form that can be published. Also, we think there is a great need for persons concerned with the education of teachers in the various States, either as consultants, as senior masters or at teacher training institutions to spend time working with the Project. We believe that active involvement by science teachers and others concerned with science education is essential if our program is to have wide acceptance in Australian schools.

## The aims of the teacher education program

The aims of our teacher education program will be twofold:

1. To establish in teachers a set of project aims, objectives, and teaching methods which are congruent with those of the ASEP program.

2. To maintain the fidelity of these aims, objectives and teaching methods in teachers over an extended period of time.

If we look at other projects, many have tried to instil initially the aims, objectives and methods of the program in teachers. There has been little attempt to see that this fidelity is maintained from school to school and teacher to teacher over time. Indeed regression to the mean is probably as true of teacher behaviour as it is in statistical analysis of test results.

Thus, we must set up a system which provides extensive initial education - a 'conversion course' as it were, and also develop a long range program for ensuring that the teachers' skills, competencies, and understandings are continually being up-graded or maintained at the desired level. At the present time we see the aims of the teacher education program extending only to the trial teachers.

## A proposal for a teacher education program

The teacher education program should be developed in five stages:

1. The preparation of teachers for initial trials.
2. The preparation of a wider sample of teachers for a second trial of materials.
3. The preparation of teachers already in the field for the use of published materials.
4. The preparation of trainee teachers in colleges and universities to use the materials.
5. The continuing up-grading of the teachers in the field who are using the materials.

We see the Project at the present time as being almost completely responsible for the implementation of Stage 1. This first group of teachers will be small and easily managed within the resources of the Project. Responsibility for the education of teachers in the second trial stage we hope we can be shared by the Project and the in-service organizations and science teacher organizations already existing in each State.

We shall advise on the form of the preparation to be provided within the administrative limitations of the States, and at the same time help these organizations set up a mechanism to implement Stage 3, when teachers are prepared to use the published materials.

The Project is only funded to a pre-publication stage. We can justify spending funds on Stages 1 and 2 and for setting up a mechanism for Stage 3. Extra funds would be needed to carry out Stage 3 after all trials are complete.

Stage 4, the preparation of pre-service teachers to use the ASEP materials, is an extremely important one. We believe we have a role in working with teacher training institutions so that student teachers may become conversant with the aims and objectives of the ASEP program. Part of their experience should be with materials, even in a trial form as they are developed, in student teaching or micro teaching situations.

The extent to which we can work with teacher pre-service institutions, both teachers' colleges and universities is still to be pursued. We believe, however, that because so many young science teachers start their careers teaching science to grades 7-10, it would help them considerably to gain early experience with the materials they are likely to use. It may be possible to have some very promising student teachers working with the Project as part of their practical training. This also is an area yet to be pursued.

Stages 3 and 5 are post-project operations and are in a sense complementary. Stage 3 must begin before the materials are published if there is to be a sufficiently large group of teachers prepared to use them when they eventually arrive on the market. There is no worse experience for a teacher than to have thrust upon him materials which he did not request, and which he is not trained to use. This has happened before and the results have been disastrous. It need not happen with ASEP if adequate planning and funds are available to carry on this task when the present Project is terminated.

## A RESOURCE SERVICE FOR TEACHERS

We see the Project as having an important role in the dissemination of ideas on the teaching of science throughout Australia. We see it as having a function to help teachers forget State boundaries and to share instructional techniques, teaching tips, resources, and ways of doing things. This can be done by Newsletter, through existing science teacher publications, by having teachers from one State demonstrate at ASEP workshops in another, and by building up an extensive display area initially at the headquarters of ASEP, which could extend to branches in strategic points around the country when ASEP funding terminates.

The services to be supplied by ASEP are necessarily limited, and will serve only the developers of the Project. In this discussion we go well beyond what can be provided by the Project so that the Conference may establish priorities for operations in this area.

We could develop a series of booklets which contain rewrites in simple terms of recent scientific advances described in scientific journals or in the press. These could be a most useful classroom resource.

We could establish liaison with schools across the country to take data on weather conditions, hours of sunlight, salinity of water, or whatever may be of common interest to students in different schools.

We could act as a source of information on science, providing answers to queries that teachers and students may require.

We could experiment with activities suggested by teachers, and put them out in a form most useful to other teachers. Existing science journals may provide the medium for communication.

We could act as a resource centre for audio-visual aids of all kinds and maintain catalogues of existing published materials that may be useful as resources for teachers.

A service branch could also act in an advisory capacity to businesses and large firms which produce large amounts of material supposedly for use in schools. The oil, steel and mining industries, the food industry and many others are well known for the production of free and inexpensive materials useful to schools. If their activities could be co-ordinated so that the materials they produce are of maximum usefulness in our schools, gains could be made both by industry and education.

We could work closely with the ABC in the development of radio and television programs that help foster the aims of the Project. We could explore the role science oriented groups like CSIRO, zoological societies, naturalist clubs etc., could play in the Project.

As pointed out earlier, many of these ideas range well outside the notion of simply servicing the ASEP materials. However, in servicing the materials, the structure would be established for a wider expansion of the service side, perhaps to parallel the expansion of the teacher education program at the end of the funded section of the Project.

## THE TRIAL OF MATERIALS DEVELOPED

No firm guidelines have been established in other projects regarding the optimum number of trials, nor how best these trials should be carried out. Some broad principles have emerged which we hope to implement in the trial situation.

In budgeting for the Project, two trials have been allowed for, with a rewrite after each trial, so that by the time the materials reach the pre-publication stage, they will have undergone an initial writing and two re-writes. This seems to be the minimum amount of revision necessary to ensure validity of the materials on the criteria stated earlier. Unfortunately two rewrites will still mainly give data at the formative evaluation stage, and it would only be after extensive trial of materials after this second rewrite with as many as 200 teachers, that summative data on the total program could be gathered. We do not even know, for example, whether for the second trial, all the materials could be tried out in sequence with any given class. The Project is designed to stop short of any massive summative evaluation at a pre-publication stage.

### The first trial

We believe that the first trial should be kept small so that the developers of the materials, the evaluators, and the teachers can all feel part of the same team. We believe that committted volunteers are much more desirable at this stage, and can give more positive information than might be gained from a wider group of teachers who may be indifferent to what we are trying to do. We think that there will be a sufficient range of teaching ability among volunteers to give a significant cross-section of approaches to teaching science.

In the first trial stage, gross errors and inconsistencies are being sought, and we believe if a compromise has to be made in production between speed and quality, the emphasis must be on speed. It is more important in the time schedule we have, to get materials into schools in a relatively rough form for trial than it is to waste time polishing them too carefully. For this reason, it is important to have volunteers who will be prepared to put up with difficulties associated with trying to teach from imperfect materials.

We believe that the development of the teacher's guide is an important part of the development of the materials, with information gained from this first trial forming the basis for teacher direction in a much larger second trial. We look on the first trial as being one where information is gained on the design of specific learning experiences, and on possible ways the materials can be used in different classroom situations.

Close co-operation between trial teachers and the developers will have to be maintained, and this will be difficult in a country as large as Australia. We propose to have between 15 and 20 teachers in Victoria involved in the first trial. These teachers will be volunteers from both State and Independent schools, located fairly close to ASEP headquarters. They will be coordinated by ASEP staff, and will undergo a familiarization program at ASEP. We hope to select these teachers toward the end of the first term, so that the teacher education program can start in the second term.

We would like to have one afternoon every two weeks set aside during the second term for them to come to ASEP headquarters so that teachers can gain experience with the materials as they are being developed.to first trial stage in the period May to September. This is to prepare the teachers for the first trial of the first materials in their classrooms in the third term. The bi-weekly meetings ought continue in the second term to help the feed-back between trial teachers and developers.

We hope that the Education Department and Independent schools can give half day release for these teachers, with the Project paying any travelling and incidental expenses involved, and, of course, supplying the materials. We believe one afternoon every two weeks at ASEP headquarters is essential for effective trial, while the other afternoon in the alternate week ought be left free for the teacher in the school to plan his own work with the materials.

It is probable that we will take up the trial teachers in two sections, to parallel the dual uptake of writers in April and September. If this is done, the above plan would be initiated at the beginning of Term II for half the group and Term III for the second half.

It is unfortunate that we will be unable to conduct as extensive a first trial in each of the other States as we will in Victoria. We believe that many of the gross inadequancies of materials developed will be "State free", and can best be determined close to the Project. More subtle differences needed for different States or different schools will come out in the second trial, or from general comments from the State Advisory Committees based on their own trials.

We propose to make up to ten sets of trial materials available to each of the States for trial in their schools. We believe the organization of these trials is best done by the State Advisory Committees themselves, each appointing their own trial coordinator, and deciding among the volunteer teachers in their State, which ones should try the materials.

We would like to have each of the trials coordinators in Melbourne for a week in June for them to gain information on the conducting of trials and general philosophy to take back to their trial teachers. During September, just prior to the start of trials in schools, a member of Project staff could go to each State for at least two days to help initiate the trials among teachers selected for this in each State, if they require it.

From this point on, feed-back from the State should be directed through the trials coordinators, who will all be brought to Melbourne again at the conclusion of the first trials. Our staff will be available for periodic visits to the States at the request of the trials coordinator in each State during the period of trial. We have budgeted for two such visits.

Another important avenue of feed-back from the States will be for the State Advisory Committees to simply read and comment on the trials materials, and perhaps also send them out for 'expert' comment by scientists, teachers, and others interested. The extent of the trial in each State is completely up to the State, except that we do not feel that we could physically handle any more than ten.

This is a very rough outline of our proposals for the first trial. We hope to test techniques and instruments which will be used more extensively in the second trial at this stage. We believe strongly that the first trial should be kept small and manageable. Ten teachers telling you our materials are no good is just as effective as two hundred, and a lot less expensive.

## The second trial

Details of the second trial stage have not been established. The extent of the second trial may well depend on the results of the first, the requirements of the States, and on how many different types of schools trial seems necessary. There are arguments for making the number of schools anywhere between 60 and 600, depending on the amount of stratification desired, and on what questions need to be answered about the materials.

At the second trial stage it will be necessary for different segments of the work to be tried out extensively in different States. For example, one State may try out materials directed at slow learners, another the Stage I materials, and another the 'life science' theme. In this way each of the States can have a specific interest in one aspect of the Project which may be in line with a State's educational strengths. This will also permit close co-operation and ready communication among all the teachers involved in teaching that section of the work, and prevent us from spreading our resources too thinly over the whole of Australia. We could, for example, get all the teachers of the life science theme together for a working conference if they were all in one State, but not if they were scattered all over the Commonwealth.

We believe that the selection of teachers throughout Australia will have to be done in the first term of 1971 when teachers are settled in schools, and then their teacher education program can begin in Term II, 1971. The actual number of teachers required must be left open at this stage, but will be necessarily greater than that for the first trial.

## THE COST OF SERVICE

The cost of service comes high, and it will be up to this conference to help us establish priorities among the services, teacher education, and evaluation possibilities proposed. Various estimates have been made that up to a quarter of a project's resources should be spent on evaluation, and another quarter on teacher education and services. Few precedents exist except that it is generally agreed that what has usually been spent in these areas has been too low. The other problem is that one cannot separately cost evaluation, development, teacher education, services and production of materials. These are all highly related endeavours, yet decisions among them will have to be made.

The ASEP Project is completely Project budgeted, a very rare procedure in Australian education. For this reason educators are likely to over-estimate what can be accomplished with 1.2 million dollars over four and a half years. It is, after all, about the salary bill for a medium sized high school over the same period.

The cost of developing one item in a test is estimated in Australia at about $30 per item, and can be as high as $250 per item in America. The cost of printing and distributing materials is also high, so we do not want to produce more material than is needed to get all the positive feed-back we can use. We are anticipating extensive help from the States in the area of in-service education, and perhaps research. Indeed, the Project could not operate effectively without this help. We are also anticipating some co-operation with the ABC in developing programs and we will be dependent on outside organizations for help in evaluation, particularly in the summative area.

We look on the ASEP Project as being a truly national enterprise, designed to improve science education in the whole of Australia. It is a national educational experiment, and as with all experiments there is an element of risk. We have to be as prepared for failure as success - to admit to failure where it occurs, not change our criteria to make a failure seem like success, and to learn from our successes so that curriculum development in many other areas will be advanced by the results of our efforts.

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# APPENDIX

The Elementary Science Study, a program of science for students in K-8 - i.e. up to Grade 8, is now drawing to a close. The director, Frank Watson, in the October 1969 Newsletter makes some pertinent comment about his Project in retrospect which may help us in prospect.

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During the next year ESS will complete its task as a curriculum development project. The two original goals of ESS were to develop new science materials for K-8 and to change the quality of science education in the schools. As we draw our curriculum development efforts to a close, we are only too aware that our job is only half done. The two original goals of ESS were interrelated. We anticipated that new materials would be necessary to change the quality of science instruction in schools. By now, it is apparent to those of us developing materials and working with schools, that far more than materials is needed to bring about changes in the way science is taught in elementary schools. It is also clear from our experience that just changing the way science is taught will not make schools a better place for adults and children alike.

> "Science, along with other subjects, continues to be presented to students as a body of knowledge to be mastered, even if not understood. Textbooks are still the main instructional vehicle, and instruction is compartmented in ways that prevent the majority of students from recognizing continuity among subjects. Teachers persist in the role of authority - a role which requires them to assign, direct, correct, and test. Lectures and reading predominate. Class discussion too often amounts only to recitation. Questions come chiefly from the teacher. Speculation and conjecture appear rarely or not at all. Being right remains the end; obedience, the means. This is not to say that efforts have not been made by teachers or that the curriculum projects have not had important effects."
>
> from a statement by
> Randolph Brown
> Former ESS Director

It is difficult to change the conditions which force the continuation of the practices mentioned above. Too often curriculum materials have little or no effect in schools, because certain features of school life prohibit their use. Some of the factors that prevent change are isolation of teachers; physical arrangements that promote the teaching of groups rather than individuals; management of school finances in ways that are unresponsive to the needs of instruction; school organization that forces teachers to respond to the needs of administrators, instead of the other way around; lack of long-term evaluation of attitudes; and the role of schools as consumers, rather than inventors, of instructional materials.

If these problems are to be overcome, we must develop, in schools, situations which foster the ability of individuals (students, parents, teachers and administrators) to take charge of their own world. Too often people are told they will have a role in making decisions about how the school will be run, only to find that these decisions have already been made and their role is that of a rubber stamp. Schools need to be places where people are not rubber-stamped, places that are concerned with respect, trust, support, honesty, and integrity as everyday practices.

Appendix A (Contd.)

To achieve this goal is not easy. Too often the approaches taken are piecemeal in nature and do not confront the real issues. Most innovations in schools, though useful in isolated instances, fail to affect the human environment of the school. A massive effort is needed that would simultaneously concern itself with curriculum, school management, the continuous self-renewal of teachers, and the education of the public.

In the short time remaining to us, ESS will continue to work toward getting such an effort underway. It will be our task to assist and encourage those that share our vision. We will involve ourselves with individuals and school systems that are concerned with making education more relevant and meaningful than it presently seems. For those wishing to "touch earth" and renew themselves, ESS will continue to supply physical and human environments conducive to visiting. In the year that remains, ESS will be a place where the work to make schools a better place for children and adults will continue.

## ESS and the COMING YEAR

The next twelve months will involve us in bringing to a conclusion the development goal that was set some seven years ago. During that time we have been involved in the development of more than 55 units of instruction that have reached at least the trial teaching stage. Over 40 of these are now in commercial production. A total of 49 units will eventually appear in commercial form; others will appear as ESS Working Papers. In rounding out our material-development responsibilities, ESS staff will be concerned with the following activities:

1. Cooperation with Webster Division, McGraw-Hill to insure that commercial production of ESS units will continue to be of high quality and will be in accord with the specification set out by the developers on the basis of experience with materials in schools.

   We plan to have remaining unfinished units in our publisher's hands before the close of the year. We are in hopes that this will make the majority of them available to schools by the fall of 1970.

2. Preparation of several incomplete units in the form of Working Papers.

   We will put the finishing touches on some incomplete units. These units are composed of promising ideas, only partially tested in the classroom but valuable to teachers who wish some ideas for starting points. When finished, these Working Papers will be available from ESS and EDC.

3. Continuation of our In-House Workshops.

   Four week-long workshops will be conducted in Newton for science consultants, administrators, curriculum specialists, teachers, and college personnel. In these workshops, participants will work with ESS materials and acquaint themselves with the units; visit schools in which ESS materials are in use; and discuss with one another, with ESS staff members, and with people from other projects within EDC the many problems they face.

Appendix A (Contd.)

4. Documentation of the Uses of ESS materials in schools.

We will embark on a documentation project to discover what has happened to ESS materials in the schools - how they have helped teachers, and where they have been inadequate. Early this fall, we will begin collecting the data necessary to document the experiences schools have had with ESS. To assemble information, we will use questionnaires, personal interviews, and visitations to schools. The data collected will be made available for general use through a series of reports. We will describe and analyze how schools have implemented and evaluated ESS materials. Schemes of staff utilization developed by schools for the teaching of ESS will be reported. Observers' logs will describe how schools have set up material resource centers and operated workshops.

Frank Watson, Director.

## EVALUATION - PERSPECTIVES AND POSSIBILITIES -

- L Blazely

In this paper I hope to present some of the major problems which face anyone engaged in evaluation activities in education. Having failed to provide solutions to these problems I will then attempt to impose a general organization on the area. This will be followed by a discussion of some of the issues which seem to be of importance for those involved in curriculum innovation.

Out of it all will probably emerge that for a number of reasons the prospects for evaluation in ASEP or any other curriculum project are not very bright and we cannot expect evaluation to provide an unequivocal answer to many of the problems that will be faced.

### The Problems:

Let me illustrate the first problem by a short story. The lady had parked her car across the drive way of the fire station. While the policeman was booking her he asked why she had done it. She replied that it was because the sign said 'Fine for Parking.'

Unfortunately many terms in education assume a meaning only in the context in which they are used and very often the context does not provide sufficient clues for adequate interpretation.

The word evaluation provides an adequate example. Every three years the Review of Education Research publishes an issue on 'Curriculum Planning and Development'. In 1963 a chapter was devoted to Curriculum Research. By 1966 the chapter dealing with the same issues had become 'Curriculum Research and Evaluation' and in the latest issue it was simply entitled 'Curriculum Evaluation'. This suggests some lack of clear distinction between the terms research and evaluation.

Perhaps the term is too general and hence cannot be used effectively to communicate precise ideas. Hilda Taba says that 'the use of the term evaluation to cover a great variety of meanings and to describe many processes has caused considerable confusion.'

Curriculum knowledge, concepts understanding and objectives are some other widely used terms which are affected by the same shortcomings. Together they aid to a language which makes effective communication difficult.

The second problem relates to the published educational literature on the topic of evaluation. The problem is not one of quantity but rather of quality. In the early stages of the preparation of this paper I had no difficulty in finding twenty or more books and articles which, judging by their titles, were highly relevant. However, I was soon able to discard half of them as doing nothing more than introducing me to some elementary statistics and describing a few properties of various type tests and how I might go about producing them and administering them to students. Most of the others were couched in such vague terms and developed such trivial generalizations that they only served to increase my confusion.

Fortunately I found one or two attempts to organize the field into manageable categories, to summarize pertinent research findings and to suggest strategies for both research and evaluation. The difficulty became that none of these went about the organization of the field and the development of strategies in the same way. The absence of a clear and generally accepted organization of the field is a real impediment to the development of useful research and evaluation. Several well-known authors have commented on this point.

Goodland comments that'there was no carefully engineered framework for identifying relationships among complex and interacting phenomena and insisted that curriculum evaluation must be differentiated into definable and researchable subject matter'

Bloom stated that 'the construction of a clear map from which implications for research and evaluation may be drawn is a critical and necessary step'. According to Rath 'it would appear that curriculum research and evaluation could be improved considerably through the use of adequate frames of reference with which hypotheses may be generated'. Clearly then we need a map, classification, model, codification, call it what you like, of a system as a starting point before research and evaluation can proceed efficiently As I see it this is largely, if not solely, a logical problem of organizing the component elements and processes of the system.

Having obtained an organization one should then be able to fill in any established theory relating to the relationships and interaction patterns between the components. As well, the map provides an opportunity to generate hypotheses which in turn can be tested and used to increase the theory. The second step is largely empirical.

The map and theory will incorporate language that has reasonable definition. Given the above I think we might be in a position to develop some strategies for evaluation and perhaps make it a more useful process in curriculum development and other aspects of education.

By the very nature of education it is unlikely that we will ever be able to state generalizations with the same degree of certainity as scientists can in their field. We should not be unduly perturbed by this and should not use it as an argument for doing nothing.

There are numerous attempts to organize the field of education or some particular aspect of it into a logical framework. Perhaps the most useful are those which employ the techniques of systems analysis. This requires one to separate out three aspects of a system, namely, the purpose, process and content. All aspects are important.

The spelling out of purpose is essential on a number of grounds. The matter has been dealt with previously in this meeting but in the context of evaluation it is again useful to raise it, for without clearly defined purpose, evaluation is a fairly futile process. How is it possible to judge without having criteria against which processes can be made?

In a curriculum development project one way to classify the processes is to make an immediate distinction between development and implementation. Developmental processes include analysis, writing, trialing and publishing while implementation might be subdivided into teacher preparation, dissemination and servicing.

The content consists of people, a physical environment in which learning takes place and a set of curriculum or learning materials. Each of these may be subdivided. For example the general class people include students, teachers, administrators, curriculum writers and advisors.

Now let us return to evaluation.

One can evaluate anything about the school's curriculum: its objectives, its scope, the quality of personnel in charge of it, the capacities of students, the relevance, sequencing and relative importance of various materials, the degree to which objectives are implemented, the cost of curriculum materials, the relevance of a given learning theory to the curriculum, and so on.

The evaluation process as it refers to these may be more or less systematic and may be based on evidence of varying degrees of comprehensiveness and objectivity. In one sense any decision to act in a certain way arises from an evaluation even though this may not be at a conscious level. For example in preparing materials it may not occur to the writer that some students are boys and others are girls. He will unconsciously assume that the material is relevant to both and will be tacitly continuing a traditional practice without having data on which to base a decision.

The evaluation process can be categorized on a scale by describing the two end points and a situation somewhere between them.

It may be simply the rendering of a value judgement based on sheer opinion. This type of evaluation is best illustrated by the Gallup Poll technique. We ask 2000 people (this seems to be the magic number) what they feel children should know about science and in view of their responses we judge the value of the stated objectives of our curriculum. Again we may ask 200 leaving physics teachers in Victoria whether the present course is satisfactory. If 80% of them say yes it is satisfactory, we would most likely judge that it is not worth making any changes to the curriculum at this stage.

While there are obvious shortcomings at this level of evaluation I do not wish to be over critical of it. In many instances it may be the only course open. While in other cases the importance of the subsequent decision may not warrant a greater expenditure of human and material resources.

Evaluation may also represent a fairly systematic description with some weighing of evidence from one or more sources.

In the extreme it will describe a process which includes a careful gathering of evidence on the attainment of some end, a forming of judgements on the basis of that evidence and a weighing of evidence against certain criteria.

Any evaluation must involve an element of human judgement. A computer, for instance, cannot point out a decision unless the limits or cut off points which the evaluator is willing to accept have been programmed into it. The person or group making the evaluative decisions may also be categorized. The teacher, the central administration, the curriculum developer and the independent investigator will all make judgements about aspects of any new curriculum program. Most of the judgement will not or only partially overlap but nevertheless it may become crucial that resulting decisions are not in conflict and are not logically inconsistent. There is no point in having a set of carefully produced curriculum materials if the central administration decides that it is too costly to subsidize in schools.

Another way of classifying evaluation activities and hence increasing our understanding of the term is to consider the stages during curriculum development and implementation at which evaluation can go on.

'Reflective' evaluation requires judgements about the suitability of the purpose, aims, objectives of the curriculum considered in terms of the supra-systems of education and of society.

We spent some time on Monday afternoon trying to decide whether the statement about the general aim of the project contained in the paper given by Mr Howard was satisfactory. In our collective wisdom we evaluated the statement by bringing forward criteria we felt were appropriate to our task and by applying these came to the decision that amendment was necessary.

Reflective evaluation probably becomes more important when it is applied to the more detailed objectives of a curriculum. It is incumbent upon any curriculum group to think and rethink whether their objectives can be substantiated on the basis of the needs of the student, the needs of society and the structure content and processes of the discipline with which they are dealing.

It is difficult to gather objective data to use in reflective evaluation and hence the process will usually mean that a variety of expert opinions about the relative importance of various sources will have to be combined in some way. Finally, reflective evaluation should proceed before there is irrevocable commitment to certain curriculum materials.

Formative evaluation relates to the trialing of materials as they are developed. According to Scriven 'any curriculum builder is almost automatically engaged in formative evaluation, except in a very strict interpretation of "evaluation." He is presumably doing what he is doing because he judges that the material being presented in the existing curriculum is unsatisfactory. So, as he proceeds to construct the new material, he is constantly evaluating his own material better than that which is already current. Unless entirely ignorant of one's shortcomings as a judge of one's own work, he is presumably engaged in field testing the work which is being developed and in so doing he gets feedback on the basis of which he again produces revisions'.

Thus, the curriculum writer should set up a preparation-trial-evaluation-revision cycle. He prepares his materials with a background knowledge of the way students learn, their previous learning, the physical environment in which they learn and the ways in which teachers can direct the learning; but his knowledge is generally imprecise and often quite indefinite. He needs to put his materials to the test realizing always that he can only observe immediate changes in the student. It is not practical for him to wait for the possible emergence of long term goals.

In science we can generally predict if A is what we think it is then when we subject it to process P, B will be observed. In the crucial test, if B does not emerge than our assumption of the nature of A was not correct. Unfortunately the same situation of the non-emergence of B in education might be due to the inappropriateness of A or it might result from wrong assumptions about the process P. In less abstract terms because our theories of learning are not fully developed the non emergence of the appropriate change in the student might be due to the nature of the curriculum materials or it might be due to the inappropriateness of the technique adopted by the teacher or to some other factor. These are the additional problems faced by the educational evaluator.

On reading over the last few paragraphs it might appear that the curriculum writer must evaluate his own materials. This is not so. He can employ someone else to do this for him. In fact, such a procedure is probably more desirable provided the evaluator is fully conversant and in sympathy with what the curriculum is attempting to do.

If formative evaluation is that which helps to improve the course while it is still fluid then summative evaluation appraises a product already placed on the market. Too frequently a new curriculum is implemented and then left as though the problem had been solved. Everyone conveniently ignores such matters as the possible difference between a micro and a full scale introduction; they forget that many teachers have a well developed facility for adapting a new curriculum to conform to the old and so on. The tendency is that after a few years a group will emerge clamouring for a new curriculum. Their summative evaluation is unlikely to be based on carefully collected objective data.

Perhaps it is necessary to rejuvenate teachers every few years by introducing a new curriculum but it is unfortunate if the new project is not built on sound, progressively collected, summative evaluation of the old.

The above suggests that the important stages for evaluation are before the writing, during the writing and after implementation.

Both formative and summative evaluation are, in a sense, the assessment of the extent to which the content and processes of the system have been successful in achieving the purpose. From this it might appear that all we need to be able to do is to recognize and measure the existence of the appropriate potential in the student. If this exists to an acceptable extent then it is not necessary to know of the inter-relations between the elements of the content and the influences of these elements or the processes of the system. Such an assumption would be naive and inevitably we must be able to measure a good deal more than the state of the students learning.

Let us turn our attention then to the prospects for evaluation in ASEP.

First and foremost very little effective evaluation can occur without definite and detailed specification of objectives. Almost all evaluation will come back in the end to criteria arising from the objectives. Obviously from the discussion over the past few days, the Project has a fair way to develop in this direction.

Given an acceptable statement of objectives and given that adequate reflective evaluation has gone on, the project will principally be concerned with formative evaluation.

As I see it there are four main areas of decisions about the formative evaluation that the project might undertake.

First there must be a delineation of those aspects of the projects to which the most effort will be directed. Then there must be evolved a plan which ensures that the results of the evaluation can be obtained in time to influence the development of the materials. Thirdly, there are certain problems of technique and strategy which must be solved. Lastly, consideration must be given to deciding who should undertake the evaluation.

If we look to other projects for guidance we find a vast number without any apparent evaluation programme. Certainly there is no published information. The only two science projects about which I have been able to get any useful information are A.A.A.S. and Harvard Project Physics. ASEP could profitably consider both of these.

Two of the problems are reasonably simple to solve and in fact one of them has already been decided.

The people who will undertake or control the evaluation programme have been selected. The only remarks that I wish to make are that the evaluation team should not produce curriculum materials and they should use teachers and independent consultants whenever the opportunity arises. In explanation of the first comment, I am convinced that the writing of material almost inevitably produces a commitment to it in such a way that unbiased judgements become exceedingly difficult.

The matter of organizing evaluation activities to ensure they can influence the production of material along with other organizational problems are amenable to treatment by the Critical Path Analysis technique. For the uninitiated this is best illustrated by the following simple example.

Suppose three people leave point X and wish to meet again at point Y. If they select routes and modes of transport such that their expected trip times are for A - 2 hrs.
for B - 4 hrs.
and for C - 5 hrs.
Then the critical path is represented by the journey of C. Obviously it determines the earliest time at which the 3 can meet again. It is critical because any alteration to it inevitably alters the meeting time. If A's car breaks down then he may cause an alteration but this is not inevitable as he has 3 hours leeway.

C.P.A. is a technique which I believe developed from the planning of building operation but which now has considerable application in industry and commerce. I have not come across an example of its use in education but I cannot see why it should not be a very effective technique and one which seems admirably suited to the present situation.

The two remaining problems of what to evaluate and how to do it deserve some attention.

From what has been said in other sessions it is obvious that the critical importance of the teacher has been recognized. Consequently the teacher must surely be a focal point in the evaluation program. If you will permit a rather strained analogy:- if the student is the molecule of education then the teacher is the source of energy which activates this molecule.

At the risk of being taken to task I would say that before a curriculum can have any hope of success, the teacher must not only know, understand and be fully aware of the purposes of the curriculum but he must also be in agreement with them. It is a teacher of rare skill who can achieve something in which he does not believe or to which he is actively opposed.

The Project is setting up a teacher education programme to help ensure that the teacher knows about the objectives. How can the effectiveness of the programme be evaluated? The existence of this programme makes the problem of evaluation much more difficult. With a few trial teachers the project personnel by observation and discussion no doubt get the information that they needed. For the wider group more formal techniques will have to be developed.

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Can we ask a teacher to write an essay or answer an objective test without offending his professional pride? To this I do not know the answer. For the sake of the project I hope the answer is in the affirmative for I can see no subtle way by which the information may be obtained. Extensive involvement from the beginning of the project may make them more amenable to analysis. I leave the problem with the project staff.

Before moving on to consideration of the next component there is another point to be made about the evaluation of teachers. Hopefully, in the layout of materials that rare gem, the highly successful teacher, will emerge from time to time. It would be a loss if the evaluators were not able to learn a good deal from taking a long and careful look at him (or her). Flanagan and others have tried without much success to use a technique based on the same approach to increase their understanding of the pupil-teacher interaction. Nevertheless, there must be a great deal to be gained by learning how the extremes operate. The critical features may be obvious or not transferable or they may prove to be as difficult to distill as the spirit of the new curriculum but this should preclude at least an initial investigation.

Information about the materials in operation can be gained by observation of their classroom use, by analysis of the terminal behaviour of students and by seeking information from the teacher. Actual procedures will depend on the nature of the materials developed by the project. I have had to make certain assumptions in order to progress any further with this paper.

Presumably the materials will form units of one type or another. Each unit should be subjected to what might be termed a feasibility study. The writer who will naturally know what the unit is attempting to do together with at least one other person should observe the materials being used.

When feedback is expected from the teacher it will frequently be necessary to provide some training on how to make the appropriate observations or obtain the necessary data and it will always be necessary to provide checklists and details of what the teacher should look for. I doubt the usefulness of the unstructured open ended report. It most often consists of vague generalizations which give few directions or criteria for rewriting material.

When feed back is sought from teachers it must be received amiably and be seen to be used. Grobman puts it this way. 'It is important that reports be read and that teachers know they are read. This does not mean that every suggested modification must be made, but unless the project is willing to consider suggestions from all sources with the same degree of open mindedness, requests for teacher suggestions will build resentment rather than rapport. If the project is defensive or implies that if the teacher really understood his project matter he would not make stupid criticisms, the teacher will soon get the message and his feedback, if it continues at all, will consist of meaningless platitudes and generalizations.' The message to ASEP is clear.

Obviously the performance of the students provides the curriculum developer with critical information about the effectiveness of the materials. In the short term and perhaps in the long term too there are severe restrictions on what we can find out from the child. We can measure with some success the facts that he has accumulated as a result of being "exposed" to a unit. We may even be able to measure or detect the development of the understanding of certain ideas but any behaviour that is assumed to be slowly aggregated or that may emerge in the long term can never become part of the formative evaluation process.

Partly as an aside I would like to mention briefly the problems of measuring and hence evaluating the development of attributes related to objectives outside the cognitive domain. At one stage I was prepared to argue that if it could not be measured with some objectivity it was not worth including in the objectives as it more or less degenerated to a pious hope. I am now not so sure that pious hopes are not admissable. Like many other issues the more one thinks about them the less sure one becomes.

If we now return to the facts and understandings which I think we can measure there are three points to make. There are a number of classifications which facilitate the systematic development of test material for collecting information about students. Bloom in a general setting, Nedels in physics and Klinckman in biology have all provided an excellent basis for use in test development.

While a grid is a necessary prerequisite it will not guarantee the quality of the instruments that are produced. Traditionally, has partly been determined by a process of item analysis. I wish to suggest that this is a technique based on differentiation between students and hence are part of the process of gathering data on which to base formative evaluation is quite inappropriate. What we need is some way of determining whether a question tells us what we think it does about the atudents. Perhaps the only way to find this out is to actually talk to a student or to a number of students.

Thirdly there is the question of what level of performance by the students the evaluator will accept as an indication that the material is satisfactory. As in any quality control decision it seems necessary to set up arbitrary limits such as by saying that unless 80% of the students in the trial class get the correct answer then the material to which the question relates should be rewritten. Another way of doing this might be to say that unless the individual student gets 80% of the questions correct then the material has not been successful with him.

There are other issues which have not been mentioned. For example, there are techniques for determining the appropriateness of a given sequencing of units, reading comprehension level and the like. I do not propose to deal with them here.

The problems of summative evaluation have many features in common with formative evaluation together with some unique to itself. I've searched the literature for a plan for undertaking summative evaluation, but without success. I've tried to organize the elements into some manageable system myself but again without success. I've even tried to list a few simple, pertinent generalization but the set never seems to convey what I want it to convey. Rather than open up a whole field, knowing from the start that very little will come from the investigation, I felt that it might be better to read to you a set of propositions suggested by Levy in a recent issue of the Journal of Curriculum Studies.

1. That to be worthy of study a new method or new curriculum should be sufficiently distinct from the pre-existing educational climate as to create conflict and controversy.
2. That any system (of instruction), or almost any system is better than no system.

3. That amongst currently competing systematic approaches no single system is likely to be unambiguously superior to any system.

4. That if two or more educational systems may be evaluated on the same scale and judged by the same criteria, then the systems are not sufficiently distinct to be worthy of study.

5. That the effective teacher is not readily identified with any particular personality or method or system but is adaptive across a variety of pupil-teacher-topic interactions.

Briefly what I have tried to say is this:

1. It would be wonderful if we had in education a language which would allow us to communicate fully an idea in a paragraph instead of in a chapter,
2. We need a comprehensive codification of the field of curriculum research andevaluation.
3. We need a greater background of consistent research findings to guide the development and evaluation of the curriculum.
4. Evaluation activities can be codified in a variety of ways.
5. A curriculum development programme is concerned initially with reflective evaluation.
6. Formative evaluation will help to guide and direct the actual production of curriculum materials.
7. Formative evaluation involves decisions about what to evaluate, who undertakes the evaluation, how the evaluation fits into the production process and the selection or development of the appropriate techniques for obtaining the data on which evaluation can be based.
8. Summative evaluation does not assume a major role in the curriculum production process but a project should take steps to see that summative evaluation of their product is undertaken in order to facilitate minor revision and the eventual development of the 'next generation' curriculum.

Before vacating the stage I feel obliged to explain that the synopsis was written well in advance of this paper. Actually it was compiled during the Xmas party which I think accounts, for the inclusion of the term 'compiler language'. I have a vague recollection of some crazy notion of passing all the writings about curriculum research and evaluation through a converter which organized and translated them into a single comprehensive entity. The fuel to run the converter was to be a compiled language. Unfortunately the creative urge has passed and I can only leave the development of the idea to another time and place,

## ASEP CONFERENCE

## SYNDICATE SESSION - WEDNESDAY

There is a limit to time, finance, and other resources available. These must be portioned between the development of materials and servicing the materials. The executive needs some guidance on the relative proportions of effort to be devoted to the five purposes of the Project. It also wishes the Conference to establish some priorities within the areas of evaluation, teacher education, and services.

It would assist the organization of the products of the discussion if each syndicate uses the questions set out below for both the discussion and the syndicate reports. Additional questions considered to be of equal or greater importance should be added.

### Question 1.

What criteria should the executive ~~adopt~~ consider in its attempt to balance the proportions of effort devoted to the various Purposes?

1.1 What are the criteria?

1.2 What are the proportions of effort?

### Question 2.

The executive is to establish a system for evaluating the materials being produced.

2.1 What are the essential components of the system?

WEDNESDAY (Continued)

2.2 What are the priorities among these components?

Question 3.

The executive is to establish a model of a teacher education program and implement it to the extent of servicing the trial phase.

3.1 What are the essential components of such a program?

3.2 What are the priorities among the components?

Question 4.

The executive is to service the trial phase of materials development.

4.1 What are the essential components of the service program to be provided?

WEDNESDAY (Continued)

4.2 What are the priorities among the components?

Question 5.

What principles should guide the establishment of trials of ASEP materials?

5.1 The first trial?

5.2 The second trial?

5.3 A future trial?

# QUESTIONS FROM GROUPS FOR WEDNESDAY SYNDICATE SESSIONS

The questions directed at evaluation from the Sunday evening group meetings are reproduced below. They are listed under question headings which correspond roughly to those decided by the executive prior to the Conference. It would be helpful to those eventually having to establish order and coherence from the afternoon's deliberations for these specific questions to be discussed (if the syndicates wish to discuss them) as part of the broader questions asked on the accompanying sheet previously prepared by the executive.

## Area 1

1 What fraction of the resources should be allotted to evaluation as against production?

## Area 2

1 What are differences between 'pilot trial' evaluation and the wider evaluation of the penultimate form of materials?

2 How can the 'continuous strands' which will appear in the materials for the four year project be evaluated i.e. how can the continuity aspects be evaluated?

3 How do we evaluate the effectiveness of the materials in providing for individual differences?

4 How do we determine point of entry to the materials? e.g. Science-readiness tests - can these be designed and how effective are they?

5 What the effects of ASEP on Science education in Australia as compared with the present status quo?
How far should project resources be reserved for an evaluation of this kind?

6 Should the materials be tried with some teachers, who are inadequately or not at all prepared?

## Area 3

1 How can the effectiveness of any teacher training program be assessed?

2 How can teachers be helped to accept new materials?

3 What are the relative weights which should be given to the different ways of obtaining feedback e.g. teachers' reports on effectiveness; observations by an independent observer; pencil & paper feedback?

4 Should it be an obligation of the project to retrain (train) teachers to use project materials, apart from trial teachers?

## Area 5

1 Is it valid, or expedient, to attempt pre-evaluation' i.e. evaluation before teachers are given any new materials?

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| The kinds of desired changes will determine the relative allotment of effort, funds and time. | The main criterion is seen to be to improve the quality of science teaching in Australian schools in grades 7-10. Choice of other criteria must be based on the extent to which they support the main criterion. | Current availability of resources, information, materials. Known or judged quality of these resources, information and materials. Availability of funds. | To (1) Establish the [illegible] goals of the [illegible].<br>(2) Scrutinise existing materials and projects to select or adapt any material suitable for ASEP materials.<br>(3) Survey the [illegible] of other curriculum projects with regard to teacher training.<br>(4) Consider the degree of teacher involvement in the development of materials which will [illegible] teacher training.<br>(5) Consider the extent to which [illegible] personnel can be involved as consultants, organisers, specialists etc. on the Project.<br>(6) Organise teacher training schemes in the States.<br>(7) Consider the importance of essential and peripheral services such as provision, distribution and trial of materials. |

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| | Room 1 | Room | Roo 3 | Room 4 |
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| 1.2 | A greater proportion should be devoted to teacher education than implied by the staffing allotment. | The order of importance of the Purposes is agreed to be one, four, three, two, five. We are unable to suggest proportions other than 1 should receive most (at least at the start) and 5 least. The establishment of the resource centre is seen as a possible beginning for a very worthwhile future development in Australian education. | As a percentage budget allocation:<br>Purpose 1 (development) 45<br>2 (current practices) 5<br>3 (evaluation) 20<br>4 (teacher education) 20<br>5 (resource service) 10<br>Priorities: Purposes 1, 3 and 4 are of equal priority and of primary importance. | As a working basis a cost weighting of:<br>Materials Development 50%<br>Teacher Education 25%<br>Evaluation & Services 25%<br>Rider: Teachers' Guide Materials are to be regarded as part of services.<br>A number of other assumptions such as comparability of weighting in other projects has been used as a basis for this cost weighting. |
| 2.1 | 1. Measurement of changes produced<br>a) in students<br>b) in teachers<br>e.g. promotion of self-innovation.<br>2. Important component: development of test procedures for outcomes other than those in the cognitive domain. | These are principally those listed in Dr.Ramsey's paper. Our list if:<br>a) Teacher reports and questionnaires both written and verbal from individuals and groups.<br>b) Classroom visitations.<br>c) Student interviews and questionnaires.<br>d) Test results (pencil and paper). | The components of a system for evaluation of the ASEP opperation are:<br>The existing situation, student outcomes, teacher outcomes, teacher education programme, the present Project for the benefit of future curriculum projects, the present Project for the information of funding authorities. The components of the evaluation system to be applied in each of these areas are:<br>Planning and production, use of instruments, processing the data, conclusions.<br>- remembering that formative evaluation is concerned with the materials developed. | 1. Systematic critical appraisal of the materials by Project staff prior to the first external trial.<br>2. The internal appraisal should involve pilot trials with children.<br>3. First trial:<br>Project staff should visit schools and collect informal, as well as formal, feedback.<br>4. Second trial:<br>Teachers should be in regional groups and organize regular meetings.<br>5. Some kind of standard feedback procedure should be established in the early stages of evaluation planning.<br>6. Testing should include attempts to evaluate performance on specific and predetermined aspects of the materials. |
| | Room 4 (Contd)<br>7. Standard (TOUS, STEP, and comprehension) tests should be used in evaluation.<br>8. A central advisory committee should be established to periodically check on philosophical validity of the testing. | | | |

Best Avialable

|  | Room 1 | Room 2 | Room 3 | Room 4 |
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| 2.2 | Priority should be given to testing units immediately on development before even the first trial (possibly by the developer). | 1. Teacher reports and visitations to classrooms (equal).<br>2. Tests.<br>3. Student interviews & questionnaires. |  | 1. Internal "armchair" appraisal of materials.<br>2. Informal material-interaction with trial schools evaluation.<br>3. Teacher feedback.<br>4. Pencil and paper evaluation.<br>Rider:<br>This group recommends that all trials should be as small as possible while remaining consistent with statistical principles. |
| 3.1 | 1. Teachers' guides<br>a) Techniques<br>b) Information.<br>2. Newsletters, sc. teachers organizations, area groups.<br>3. Pre-service training.<br>4. In-service training, including TV.<br>5. Unstructured personal contact.<br>6. P.R. (also to general public).<br>7. State Advisory Committee should consider appointing consultants to maintain contact between ASEP, teachers, teacher trainees.<br>8. Preparation of teachers for first trial.<br>9. In-service training of lecturers in tertiary institutions in time. | A. Indoctrination of teachers into the philosophy, rationale, and objectives of the Project.<br>B. Demonstration of the use of the materials and learning procedures.<br>C. Putting teachers in the position of applying the recommended procedures in the classroom situation.<br>D. Assisting teachers to judge the effectiveness of the programme.<br>E. Instructing teachers in techniques for group assessment and reporting. | Immediate and imaginative work on the model of teacher education with the realization that the present model is insufficient and ineffective.<br>Consideration of every practicible means of training. Contact between ASEP staff and teacher training institutions in all States.<br>Material for intra-school science staff discussion.<br>The teacher education model may have to give separate consideration to two probably distinct phases;<br>A. Initial education (both pre-service and in-service) which serves to establish appropriate teaching,<br>B. Subsequent education (continuing?) which serves to maintain and gives opportunity to extend such teaching. | The authority of the teacher springs from his competence to handle the materials as perceived by his class. Hence essential components of T.E. are:<br>1. Teachers should be brought in for induction processes and periodically refuelled.<br>2. Maximum involvement of teachers with developments and revision of materials.<br>3. Information about material should be disseminated as widely as possible to maintain universal interest.<br>4. Construction and provision of an adequate teachers' guide.<br>5. Open channel of communication between teacher and Project.<br>6. Display centre of Project materials. |

Best Avialable

|  | Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|---|
| 3.2 | 2,6,5; 8,1; 7,9,3,4 | Obtaining the commitment of teachers to the objectives of the project are most important. |  | All the above are considered essential. |
| 4.1 | 1.Survey of cross-section of schools.<br>2.Selection of trial schools and teachers.<br>3.Readiness of materials (hard & soft) on time.<br>4.Available materials should be relevant to the season of the trial. | Materials, teacher education, evaluation instruments and information service. We agree with the recommendations in Dr.Ramsey's paper. | We have complete confidence in the ASEP Executive. | 1.Student and teacher materials essential to the Program to be provided.<br>2.Teacher education essentia for trials.<br>3.Equipment lists and necessary specialized equipment required for first trials in all cases, and for secon trials as budget allows.<br>4.Make available second trial materials, at cost, to any schools seeking them, a soon as possible, provided the schools have undertaken a satisfactory program of in-service work at their own expense.<br>5.Service to be established to advise on suitability of films, aids and reference materials used with the Project.<br>6.Clearinghouse service for ideas from within or without the trial schools. |
| 4.2 |  | With the exception of the information service, which is seen to be subsidiary, the other three elements mentioned are interdependent and can't be ranked. |  | 1-4 of first priority.<br>5-6 of secondary importance. |

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 5.1 Selection should include non-JSSP schools. Units should be tried in States for which they are particularly suitable. | The purpose of this trial is to determine the 'workability' of the materials. We recommend:<br>a) a small number of schools in each state.<br>b)a cross-section of school types.<br>c)ready accessibility to ASEP headquarters or trial co-ordinators in other States.<br>d)individual class teachers to be committed volunteers.<br>e)trial materials should be provided free and be recalled after the trial. | Localization of the first trial is realistic. | Vic. 1.Small trials.<br>2.Location close to the Project centre.<br>3.Teachers selected on basis of<br>(a) training<br>(b) willingness to cooperate.<br>4.Trial schools to be as diverse as possible, within constraints 1-3 above.<br>5.Problems within the materials to be determined by first trial.<br>Other States.<br>State committees responsible for obtaining materials for first trials. No compulsion to use these. |
| 5.2 Each unit should be available for testing in each State. The necessity for a second trial has been questioned by a minority of members of the syndicate. | The number of classes should be as small as possible consistent with valid results.<br>Some teachers should conduct both first and second trials of particular units. Trial materials should be provided free. | | This is dependent on first trial results. Many variables in schools will affect the outcome of the trials. The second trial is to identify some of these variables.<br>1.10 to 15 schools to be used covering the following types: State, Independent, Catholic, Male, Female, Co-ed., Metropolitan, Country, Correspondence.<br>2.Teachers should be stratified according to years of experience, qualifications.<br>3.Poor discipline areas or situations to be included when trialling.<br>4.Class sizes to be taken into consideration. |
| Memo. ASEP should ensure that final materials may be purchased through Commonwealth science grants. | | | |

Plenary session - Wednesday

1.1 The following is to be regarded as a set of tasks to be noted by the executive. No criteria are recommended.

(1) Establish the broad goals of the Project.
(2) Scrutinize existing materials and projects to select or adapt any material suitable for ASEP materials.
(3) Survey the experiences of other curriculum projects with regard to teacher training.
(4) Consider the degree of teacher involvement in the development of materials which will influence teacher training.
(5) Consider the extent to which part-time personnel can be involved as consultants, organizers, specialists etc. on the Project.
(6) Organize teacher training schemes in the States.
(7) Consider the importance of essential and peripheral services such as provision, distribution and trial of materials.

1.2 Development of materials and teacher education should receive highest proportions of effort. A rough indication of order of importance is considered to be Purposes 1, 4, 3, 2, 5. Amounts to be allocated to teacher education will depend on the decisions of the states.

2.1 All of the following sets of answers are submitted for the consideration by the Project:

(A) 1. Measurement of changes produced
(a) in students
(b) in teachers e.g. promotion of self-innovation.

2. Important component: development of test procedures for outcomes other than those in the cognitive domain.

(B) These are principally those listed in Dr Ramsey's paper. Our list is:

1. Teacher reports and questionnaires both written and verbal from individuals and groups.
2. Classroom visitations.
3. Student interviews and questionnaires.
4. Test results (pencil and paper).

(C) The components of a system for evaluation of the ASEP operation are:
The existing situation, student outcomes, teacher education programme, the present Project for the benefit of future curriculum projects, the present Project for the information of funding authorities. The components of the evaluation system to be applied in each of these areas are:
Planning and production, use of instruments, processing the data, conclusions. - remembering that formative evaluation is concerned with the materials developed. There is a high priority for the provision of a blueprint for the involvement of external agencies in evaluation.

(D) 1. Systematic critical appraisal of the materials by Project staff prior to the first external trial.

2. The internal appraisal should involve pilot trials with children.

3. First trial: Project staff should visit schools and collect informal, as well as formal, feedback.

4. Second trial: Teachers should be in regional groups and organize regular meetings.

5. Some kind of standard feedback procedure should be established in the early stages of evaluation planning.

Best Avialable

2.1 (cont)

6. Testing should include attempts to evaluate performance on specific and predetermined aspects of the materials.
7. Standard tests should be used in evaluation.
8. A central advisory committee should be established to periodically check on philosophical validity of the testing.

2.2 —

3.1 All of the following sets of answers are submitted for the consideration by the Project:

(A)
1. Teachers' guides
   a) Techniques
   b) Information.
2. Newsletters, sc. teachers organizations, area groups.
3. Pre-service training.
4. In-service training.
5. Unstructured personal contact.
6. P.R. (also to general public).
7. State Advisory Committee should consider appointing consultants to maintain contact between ASEP, teachers, teacher trainees.
8. Preparation of teachers for first trial.
9. In-service training of lecturers in tertiary institutions in time.

(B)
1. Indoctrination of teachers into the philosophy, rationale, and objectives of the Project.
2. Demonstration of the use of the materials and learning procedures.
3. Putting teachers in the position of applying the recommended procedures in the classroom situation.
4. Assisting teachers to judge the effectiveness of the programme.
5. Instructing teachers in techniques for group assessment and reporting.

(C) Immediate and imaginative work on the model of teacher education with the realization that the present model is insufficient and ineffective. Consideration of every practicable means of training. Contact between ASEP staff and the teacher training institutions in all States. Material for intra-school science staff discussion.
The teacher education model may have to give separate consideration to two probably distinct phases:
A. Initial education (both pre-service and in-service) which serves to establish appropriate teaching.
B. Subsequent education (continuing?) which serves to maintain and gives opportunity to extend such teaching.

(D) The authority of the teacher springs from his competence to handle the materials as perceived by his class. Hence essential components of T.E.P. are:
1. Teachers should be brought in for induction processes and periodically refuelled.
2. Maximum involvement of teachers with developments and revision of materials.
3. Information about materials should be disseminated as widely as possible to maintain universal interest.
4. Construction of provision of an adequate teachers' guide.
5. Open channel of communication between teacher and Project.
6. Display centre of Project materials.

3.1 (cont) The following comment is added:
Information about the project should be given to senior science teachers, headmasters, and other teachers not involved in the trials.

3.2 —

4.1 All of the following sets of answers are submitted for the consideration of the Project:

(A)
1. Survey of cross-section of schools.
2. Selection of trial schools and teachers.
3. Readiness of materials (hard & soft) on time.
4. Available materials should be relevant to the season of the trial.

(B) Materials, teacher education, evaluation instruments and information service. We agree with the recommendations in Dr Ramsey's paper.

(C)
1. Student and teacher materials essential to the Program to be provided.
2. Teacher education essential for trials.
3. Equipment lists and necessary specialized equipment required for the trials to be provided in all cases.
4. Trial materials should be copyright, not available to schools outside the trials, subject to recall, but available for controlled inspection.
5. Service to be established to advise on suitability of films, aids and reference materials used with the Project.
6. Clearinghouse service for ideas from within or without the trial schools.

4.2 —

5.1 All of the following sets of answers are submitted for the consideration of the Project:

(A) Selection should include non-JSSP schools.
Units should be tried in States for which they are particularly suitable.

(B) The purpose of this trial is to determine the "workability" of the materials. We recommend:
1. a small number of schools in each State.
2. a cross-section of school types.
3. ready accessibility to ASEP headquarters or trial co-ordinators in other States.
4. individual class teachers to be committed volunteers.
5. trial materials should be provided free and be recalled after the trial.

(C) Localization of the first trial is realistic.

(D) Vic.
1. Small trials.
2. Location close to the Project centre.
3. Teachers selected on basis of
   (a) training
   (b) willingness to cooperate.
4. Trial schools to be as diverse as possible. within constraints 1-3 above.
5. Problems within the materials to be determined by first trial.

Other States.
State committees responsible for obtaining materials for first trials. No compulsion to use these.

The following comment is added:
First trials should take place in Victoria, but small numbers of class sets should be sent for trial to other states on request by them.

5.2 All of the following sets of answers are submitted for the consideration of the Project:

(A) Each unit should be available for testing in each State. The necessity for a second trial has been questioned by a minority of members of the syndicate.

(B) The number of classes should be as small as possible consistent with valid results.
Some teachers should conduct both first and second trials of particular units. Trial materials should be provided free.

(C) This is dependent on first trial results. Many variables in schools will affect the outcome of the trials. The second trial is to identify some of these variables.
1. 10 to 15 schools to be used covering the following types: State, Independent, Catholic, Male, Female, Co-ed., Metropolitan, Country, Correspondence.
2. Teachers should be stratified according to years of experience, qualifications.
3. Poor discipline areas or situations to be included when trialling.
4. Class sizes to be taken into consideration.

5.3 —

## THURSDAY JANUARY 22

The States and their relation to the Project

morning : comments from each State Advisory Committee

afternoon : syndicate discussion

evening : plenary session

## "THE STATES AND THE AUSTRALIAN SCIENCE EDUCATION PROJECT"

## MEMBERS OF THE STATE ADVISORY COMMITTEES

Mr D. Neale - Victoria

This sheet of paper has at this stage become too heavy for me to carry, I need a prop. It is not my speech, by the way, it is just the general pile of hand-outs which I have been sufficiently unwise to collect.

Well, I did propose to refer quite briefly to the activities of two Victorian bodies in support of this Project. The first of these is the Science Standing Committee of the Victorian Universities and Schools Examinations Board. Now this, as you probably know, has played a very active role in the initial steps towards this Project. Robert Wilkinson mentioned earlier the early work which led to JSSP, and the committee has in recent times used similar machinery to reconsider the recommended science programme for adolescents in the grade 9-10 level. We believe that this successfully involved university scientists, educationalists and practising teachers in a review of what were the big ideas in the various disciplines, and of the extent to which these might be rendered relevant to the lives of children.

A somewhat hurried synthesis of the recommendations from each of the disciplines was undertaken, and the resulting documents have been placed before teachers and submitted to this Project for its guidance and if any of you would like to look into this, I have a copy of them here, or our chairman, the chairman of the Standing Committee, Professor Fensham, would be able to give you any further information on it. But we hope that it will be helpful to the work of this Project.

Now the second of the bodies is the one to which the chairman has made reference - the State Advisory Committee - and this again is drawn from a considerable range of those who are active either in the fields of science or education. We have only met twice to make recommendations and you may still at this stage have a copy of those recommendations amongst your papers. They contain both the summary and Bob Vickery's summary of the summary and I don't really think it is necessary for me to go over them again, but I would like to make special reference to four of the points there.

How do we view JSSP? Well, we do see JSSP as one useful item amongst others which are already available and which can constitute firstly valuable interim material and subsequently one of the alternative materials available to those which will be developed by ASEP.

We believe that ASEP should quite actively encourage the development of alternative materials by other bodies as a part of a policy of covering a wide variety of approaches which we feel is essential for the success of this scheme. I think we are all agreed at this Conference that ASEP should encourage a high level of initiative on the part of both pupil and teachers and we hope that these will extend to extra classroom activities which will grow in turn into leisure interests associated with science.

We believe that ASEP should play a full part in organizing inter-State co-operation in the sharing of resources such as audio-visual aids. I think that too many of us are quite ignorant of what is available and what has been developed in other States. We hope too that their work will be the establishment of co-operation in regional consultation and material centres.

I have not used all my 10 minutes by any means, but I will finally say that we in Victoria are very keen that the Project succeeds in producing not an Australian science course, but a range of resources to nourish a rich variety of science experiences for Australian children. Thank you.

Dr R.Vickery - Western Australia

Ladies and gentlemen, I find myself in substantial agreement with what the previous speaker (Mr D.Neale) has said. There are a few things that I would like to add. I have already had one bite of this cherry and the opportunity to make some points which had a peculiarly West Australian flavour, but there are several things that I would like to add to it.

First I would like to recapitulate to say that the situation at the moment in West Australia is one of fairly general dissatisfaction with the curriculum materials that exist and the syllabus that they service, and as a consequence for this and for other, I hope, more altruistic reasons, there is a very strong commitment in West Australia to the ASEP Project.

When asked the question, with no particular constraints in terms of what exists in the States, "What sort of a programme would you like to see developed for science at this level?" the West Australian Advisory Committee came up with the document which has been distributed to you several days ago, and I don't propose to discuss any more than a few small items from it at any length. I believe that the proceedings of this Conference have emphasized several purposes of science education which received only very nominal consideration by the Advisory Committee that produced the document I distributed to you earlier. I think that the case that has been represented at this Conference by many speakers for the inclusion of such things as personal development, the development of special skills of sociability and the relevance of the child's experience and his immediate environment to the curriculum, these arguments presented have been very persuasive and I think that when these views are represented to the State Committee in West Australia, they will find a very large measure of sympathy. I think you will gather from the document the West Australian Group have produced, that the viewpoint expressed by that committee strongly favours the type of course that is structured and follows a story-line. I am certain, after having listened to the representations of various speakers at this Conference, that the Committee will rather readily accept that some less structured approach is inevitable to allow flexibility of choice within and between the States. However I think the position apparently existing between a structured sequence which can lead to hierarchical learning and an unstructured array which allows for unrestricted selection is a matter which should be viewed with a fair amount of concern. The priorities of objectives for ASEP which appear to be emerging from this Conference have, I think, a somewhat disturbing resemblance to the Science for Life sorts of programmes that were common in the UK and US about 20 years ago. You will know the sort of course that I am referring to; courses that are purportedly activity-centred or environment-centred, in which the students engaged in environmental enquiries of such things as "You and Your Home", or a rather more inviting but rather more barren title of "You and Your Body". The students emerged from these courses with a selection of inconsequential and rather unrelated trivia about science or about technology, and I can see some dangers, although I am sure it is not intended by any of the speakers who have addressed themselves to this question, I see some dangers that we may be taking some steps along this particular path.

Despite a conviction that personal and social development are important, I believe that we should not lose sight of the fact that science is a structured body of knowledge which should be learned in a structured way. I think that it is vital that we reach some compromise between flexibility and rigid sequence, a compromise that will allow an acceptable freedom of choice while at the same time allowing for the development of the hierarchical and structured development of important scientific concepts.

I would like to add only very briefly to the comments I made on Monday concerning the uncritical acceptance of existing materials from any project and here I find myself totally in accord with the remarks of the previous speaker. I think that the objectives of ASEP which have emerged over the last couple of days include objectives which are not included in the content of objectives and instructional procedures of any of the projects with which I am familiar, and this I think should lead to a conclusion that we are not considering merely a two-year extension of JSSP or a two-year extension of any other sequence of materials that might be available, but we are considering a four-year ASEP project.

There are two matters that have a particular State frame of reference, and I just want to lay these on the table very briefly.

One is the implication "Streaming" stemming from the streaming pattern to which our State along with several others is committed. Here our problem is essentially the same as that pertaining to South Australia. I know that John Mayfield intends to address himself to this, and whatever suggestions and solutions that he might propose will also be viable in the situation that exists in the West, so I don't propose to discuss it any further.

One other matter which is of peculiar State significance relates to point of entry into the programme. In three States the grade 7 students are in primary schools, and in three States the grade 7 students are in secondary schools and the conditions of staff and facilities and equipment between primary schools is now and clearly will remain very different from the comparable conditions in secondary schools. We would be very anxious that our grade 8 students do grade 8 material and that the grade 9 students do the material considered appropriate for grade 9 students and so on. This has some implications. It carries the implication that the grade 7 materials must be such that they either can be done in a primary school situation with the much more limited facilities and staff and resources available there or, alternatively, that the outcomes of grade 7 which are assumed to begin grade 8 are such that they can be met by some brief crash programme at the beginning of the grade 8 sequence, or some other compromise, but this does remain a point of difficulty for the immediate introduction of ASEP materials into States where the grade 7 students are still in primary school.

Just to recapitulate, ASEP has very keen support in the West. We hope to see some sort of compromise between tight structure and flexibility. I am certain that my Committee will re-state if asked to, that they believe that major processes and major concepts of science should emerge from the programme.

We believe that ASEP should be regarded as a four-year entity. The entry into grade 8 and the streaming of students represent peculiar problems to the West and the nature of the materials will be significant in terms of the degree to which these can be met.

Finally, I would like to congratulate the Project staff on the quality of work that has been done to this point and been laid on the table for us to view, and I think that those of us here have very great confidence in the future of this Project.

Mr G.W.Robins - Queensland

Mr Chairman, Ladies and Gentlemen -

First of all I think I have got a slight apology to make in that we, in Queensland, are not as familiar with JSSP as the other States and the other two speakers are. The other thing I would like to say before I go much further is that we have only had one State Advisory Committee meeting and that was to meet Les Dale and so we did not develop any recommendations to put to the ASEP Project.

In Queensland at the moment the position is that we have an external examination at the end of the first stage of secondary education. As a result there is a prescribed syllabus in science for grades 8, 9 and 10 and I think most people in Queensland regard this as a rather narrow and perhaps rigidly prescriptive syllabus.

There is a variety of reasons for the particular nature of this syllabus. The main ones are those we are mentioning at the moment, the nature of science teaching in the primary school in Queensland, if any, at the time the secondary school syllabus was prepared and also the traditional nature of the senior science courses. We had nothing to build on and there are other courses which demanded that we do such and such a thing. Now for some years Queensland (various bodies in Queensland) have been talking about abolishing the Junior examination, but they have done nothing much about it. If the Junior examination is abolished, then it allows a certain amount of flexibility, a chance to do something with a science course.

However just recently a Committee was appointed, headed by Dr Radford, to examine the place of the external examinations at the secondary level in Queensland and also to recommend methods of how students' achievement at this level can be measured. What the findings of that committee will be I haven't any idea, but I think there is quite a body of opinion in Queensland, hoping that they will recommend the abolition of the Junior examination. And if it is abolished, good! but even if it is not abolished, I am afraid we will have to do something about our Junior Science syllabus, for the very reasons that I have mentioned earlier. The syllabus committee very shortly, I think, will have to settle down and think about what they are going to do to this Science syllabus, irrespective of whether there is a Junior examination there or not.

It would be ideal if we had the ASEP materials on hand. We could build a course around it, but I am afraid time is going to beat us. The time factor will not allow it, but (and this is just a sort of a plug) if we could have some idea as to which way or in what direction this ASEP Project was heading regarding the development of materials, then it would be a big help to us when we come to revise the existing syllabus.

Now as to what Queensland expects from the Project.

First of all (and this is only obtained from informal talks with members of State Advisory Committee, it is not a recommendation from the State Advisory Committee, although I suspect they will most heartily agree when I go back and tell them what has happened at this time) we feel that the ASEP should develop materials for 4 years. Although we have a 5 year 3 - 2 secondary stage in Queensland, I don't think that the Project should be tied down to developing materials for any one particular State. If they develop it for 4 years then we can quite easily choose what we feel is good from the materials that they have produced.

At this particular point, (it worries me a little bit during the Conference) I feel that somewhere here at this Conference, we are expecting the ASEP to produce a curriculum or a syllabus. Well, as far as I can see the charter of the Project is to produce materials which could be used in grades 7 - 10 by any States who wish to do so.

The other thing that I would like to say is, (with not too much emphasis) that a fresh start should be made in developing the materials for these 4 years in ASEP, and that the third and fourth year should not necessarily be built upon the existing JSSP materials. I have said before, we have had very little experience of them. There has been one or two boxes used in one or two schools for experimental purposes and those boxes which were used were those which fitted our existing syllabus, so I cannot comment on the strengths and weaknesses of the JSSP. Other people are better qualified to do so, but we feel that this Project is a nation-wide one, it has broad objectives and it is going to cater for a wider population, so we feel that a new start should be made, but if in the planning of the Project they find that some of the existing JSSP materials fit very nicely into what they think should be developed, well and good.

The other thing, I imagine - I could be entirely wrong here - is that the first task of ASEP as soon as this Conference is over will be to settle down and devise a plan for four years for the materials which are going to be produced.

I presume it is not going to have a plan whereby, say, grade 7 is going to be developed first and after that has been tried and tested, then comes grade 8 and then comes grade 9 and 10 and so on. I think the State Advisory Committee in Queensland would agree with me that an overall plan should be drawn up first. If that would be so, then we in Queensland would like to have a look at it and would like to see how it is going to fit in. We would like to make some sort of recommendations, but I can assure you that the recommendations for changes will not be for radical changes.

In Queensland we are looking for some assistance at the moment in devising a secondary course for grades 8, 9 and 10, and while we don't think that any particular State has all the answers, we feel that a combined effort of this nature will probably produce something which is very good. If we could have a look at this, and I presume that is the intention of the Project, we would be quite happy.

The last thing I would like to say is that we would be happy to take part in the trials. I became a little worried last night when it was suggested that the first trials were to be confined to Victoria. There is, amongst the people who form the State Advisory Committee and the other people that I speak to in Queensland, quite an interest in ASEP and they are anxious to get going because of the deficiencies of our present syllabus, and I feel that it would be perhaps a bit of a let-down if we had to sit back and wait for say 12 months, 2 years or whatever it might be before we get cracking with the Project. If the Junior examination still persists, I can see some problems with these trials, but whatever happens, we want to take part in the trials and we will resolve these difficulties the best way that we can.

Queensland came into this Project because it felt that it was in a very important breakthrough in that it was a National programme for the improvement of science and I can assure you that you will get all the support that you ask for from Queensland, in developing these new materials.

Mr H.Carey - New South Wales

Mr Chairman, Ladies and Gentlemen -

What I am going to say does not represent a statement from the State Advisory Committee, New South Wales. I represent very largely my own opinions, but I suspect that these will turn out to be fairly close. I will cover as briefly as I can three main areas.

First, I think it may be of interest to make some reasonably clear statement about the nature of science courses in New South Wales, the junior science courses; second, to say how we think these syllabuses are related to ASEP ; and third, to say what we hope our State may gain from ASEP.

First then, the nature of New South Wales courses.

In the school curriculum, secondary school, there is a compulsory core of science for all pupils in Forms 1 to 4, grades 7 to 10. There exist four syllabuses intended for the varying needs and abilities of these students. There is an ordinary level syllabus for the great majority, there is an advanced level syllabus which consists of the ordinary level syllabus, but with some extensions. There is a modified level syllabus which is precisely that, a modification, a simpler and contracted version of the ordinary level syllabus, so you see these three syllabuses are fairly closely related in content and approach; and there is an activity syllabus for the slow-learning group. This syllabus too is basic and similar to the other three. Syllabuses have been compiled by syllabus committees consisting almost entirely in many cases of practising teachers, and they have been compiled on behalf of the Secondary School Board.

Now I think I should make one statement here that appears to be necessary, although it seems extraordinary perhaps that it may be, and I should say that Professor Harry Messel has never been a syllabus committee member nor has he been represented on it. And we hear so much about New South Wales Messel Science that one may gain the impression that he invented it, and this does not do justice to such people as Ted Barker and Roy Stanhope, Rod Maclay and Mark Bishop, who conceived the pattern of Junior Science in New South Wales and helped produce the syllabuses. So let us not call it the Messel syllabus; it was produced by an extremely hard-working body of people, experienced in science education.

All the syllabuses at all levels lay considerable stress on a number of particular things.

First, on presenting the course content as science, that is an integrated and not a separate discipline; on the existence of big ideas in science, on the view that science is both a body of knowledge and a method of inquiry, on the importance of science as a human activity, on the need for pupil activity in learning science, and on the professional freedom of the teacher to organize the course content as he sees appropriate, and to add to this where the interests of either the pupils or the teacher make it worth while to do so. So while there are syllabuses, they are not necessarily as restrictive as we imagine.

With the exception of the activity syllabus for the slow learners, examination on each is conducted at the end of Form 4 as part of the School Certificate Examination. The examinations are set by examination committees, again consisting fairly largely of practicing teachers. Pupils are awarded a level of pass at the School Certificate Science Examination depending on a combination of examination performance and school assessment, and it is intended in making the school assessment that it should take into account areas that are not measured by the examination.

That briefly is an outline of the New South Wales course.

How are these syllabuses related to ASEP and its purposes so far as they have been defined?

I think it is true that the spirit of our courses in our State is very much in accord with the ASEP rationale; the items that were presented in the Director's paper show nothing with which we would argue or disagree. The objectives are also very much in accord with those set out in Bob Vickery's paper, listing the objectives of science teaching, and the aims of science education given in the Tasmanian document.

In other words, it seems quite obvious that we are all very much in accord with the sorts of things we think should go on in science teaching and the sorts of outcomes we would hope for as a result.

What do we hope to gain from ASEP?

In case you may think that this is a mundane way of looking at things, let us just be quite clear that the States are making a financial investment in this and they do hope to get something back which will be useful. Well, what we hope for in New South Wales in fairly concrete terms (practical terms) first of all is material - material which will enable the achievement of our syllabus aims to be reached much more effectively. We would like a reasonable proportion of that material to be consistent with our own syllabus content. We would hope that it would bring about an increase of pupil involvement and activity in learning science. We hope that it will also bring about an increase in the pupils' and the teachers' interest in and enthusiasm for science, and we would hope that the materials are sufficiently flexible in format to allow teachers to use them as and when they deem to be appropriate.

In other words, we are not looking for a highly structured sequence of units or materials through which there is only one way. We do want to leave the teachers a fair degree of freedom in deciding whether or not they wish to use some or all of the material, and to the extent to use it when they deem it to be appropriate.

Finally, I would like to echo the sentiments that Bob Vickery expressed in congratulating the executive of the Project on what they have done to date and also expressing my own personal confidence in what they are going to produce. I feel very sure that the results of this Conference and other contacts with the Project, we in New South Wales are going to be delighted with the material that is produced and the sorts of effects that it will have on science teaching in our State.

Mr J. Mayfield - South Australia

Ladies and Gentlemen -

I want to make two points of a general nature, then to follow the line that has been set by other speakers and then refer to some specific State matters.

In general I have, of course, agreed with the things that have already been said and I will refer to a couple of those points as I go through.

The first point is, that we in South Australia did not sit down and write a position paper as other States may have done. We did consider the State position, but we felt that we should approach this Conference without a list of clearly-stated and perhaps limiting demands. But one of the outcomes of this Conference, we felt, had to be for our purposes a very clear statement of the intent of the Project. This is the first point that I make, and I want to be able to go back to my State and to describe very clearly the kinds of directions that the Project has decided to take and the first and positive kind of statement that I want to make, Mr.Chairman, is that very shortly after the conclusion of this Conference, as a result of the editing of the Conference materials, that South Australia would like to see a clear statement of the intent of the Project in relation to aims, pruposes, teacher and student outcomes and objectives.

I don't think that we could be satisfied with the kind of statements that have been made so far, although they have been very much improved as a result of this afternoon's discussion, but we are quite content as a State group with the kinds of considerations that are being made at present. We have assumed during this Conference that the Project has put its cards on the table. This caused me personally a little bit of concern, partly as a result of the obscuring of some of the questions that we have been asked to discuss. It has almost appeared that the Project has deliberately left matters wide open. I am sure, knowing some of the people in the Project that the questions we have been asked to discuss could have been made much more explicit. We have felt that cards have been on the table and this has been done for a different purpose. We felt that the feet of the Project have been on the ground. As I said before, we are content that the right kinds of considerations are being made.

The second point that I should like to make, particularly from a State point of view, is that we do want to be kept informed in South Australia. We must not be allowed to get the feeling that we are not needed or not in the picture as far as this Project is concerned.

We were concerned, I know, last night, at one stage that there were dangers that the Project being established in Victoria, being so good within itself, could become insular, could begin to feel no need to go outside of its own resources and that could lead to a feeling in our State that we were not being involved. I think that would be a very unhappy affair. In this regard, I might suggest, that perhaps a Newsletter, possibly tapes, could frequently flow and be the agent for an information flow from the Project to the States.

Secondly, we would also like to be involved, even if we are not quite involved in the trials as much as, say, the Victorian schools are, we would like to be involved in sustained and purposeful activity of some kind to give us this feeling of involvement.

Now there are some points, as other speakers have mentioned, that are facts of life in my State's education in science.

The first of these Bob Vickery has mentioned, and that is the different entry point which South Australia has compared with other States. I won't go into the details of it, but I would like to follow up his remarks with this statement.

I think that from the discussions we have had of some of the suggestions that have been made, that to look for the solution of the grade 7 - grade 8 problem by producing materials for use in our grade 7 will not be a satisfactory solution. That is the state of mind at the moment, but it might be worth debating later, because it would be perhaps the easiest solution to the problem. The problem has been raised in my State and it has not received very favourable support.

The second point that I make is that we have in our State various forms of organization and I am glad that Chick Carey has gone through the kinds of organization that exist in New South Wales, because they are fairly relevant to our State.

First of these is the matter of period allotment, which he doesn't mention, although I suspect he implied. We do have a fairly considerable difference in the number of periods allotted to various groups of students doing science. This, I think, will provide a problem for the Project to accommodate. The trend in our State is that Junior Science is not receiving as much time allotment as it once did; it has come down in one of our groups from 10 periods a week to a realistic 8 periods per week. Now I think what I should say here is (if it is possible) that the Project should take into account the trend in period allotment, assess this for us, and make some suggestions about it. We would like to hear what a considered opinion of period allotment in Junior Science is.

The second point on the various forms of organization refers to this matter of grouping.

We don't have curricular core syllabus material in Junior Science. We have three tracks that exist, not universally, but this is an identifiable part of our organization. The "0" track would correspond roughly to Advanced level, the "1" track would correspond roughly to the ordinary level. I think in New South Wales it would be also this, and the "2" track would be the slow-learners. The point that we made elsewhere in the Conference has been accommodated in the kinds of guidelines that have been written and that is simply this, that we would like to see the kind of grouping, or the opportunity for this kind of grouping if a school decided to use it. We would like to see that opportunity accommodated within the programme. That is a very different thing from asking the programme to design its materials about three kinds of students. We are asking only for accommodation, and I suppose that means we are asking for flexibility.

The third point is that there is a trend in our State that I have found often stated at this Conference, and that I feel important to mention this morning, a trend towards what we could call the "blurring of the subject boundaries".

Now, in Victoria, I take it that this has become General Studies. That is certainly a situation that does not exist in my State. When I say "blurring of subject boundaries", I am not talking about integration within science itself. I am not talking about blurring Physics with Chemistry, but finding meeting points of Science with other subjects on the Junior Secondary Curriculum. We have had some mention of it, but I think the problem should be made important by mentioning it this morning, and perhaps it can be summed up by saying that we would like the Project to continue to regard Science as a part of a general education at Junior Secondary level. If it can establish meeting points between Science as a subject and other subjects on the Junior curriculum, we would be delighted.

The fourth point is one that I personally have made much of during discussion and I won't offend people by speaking of it at length again this morning. But it is one about teacher education.

We have had some experience in South Australia of consultant services which may be unique. It is sometimes thought of as unique, but it probably happens in other States. Now, one of the outcomes of this consultant experience, or the kind of consultant experience that we have had is that our teacher education programme as it is now conducted is ineffective and very wasteful. The consultant service itself has revealed that there are some activities of that service that have just not borne fruit and those of you that know Viv Eyers and other consultants will have heard him say, and them say, on many occasions that the frustrations of that job are enormous and that perhaps the overriding feeling after a couple of years in the job is that you have been wasting your time.

Now that, coupled with the recognition of the Conference that teacher education is vital to the success of the Project, might lead to a new look at teacher education. I hope it does, and I hope that it can produce a very much more effective programme. In this regard, I suggest that the trials are very important and I am pleased that we are going to be involved in South Australia in those trials.

Now these are all the comments that we would make from South Australia at this stage.

We have no content requirements and some of the other things that have bothered other States.

We are content that, at this stage of the Project, we are in a good position to gain a great deal from it.

I would however like to raise one point that is slightly different to a general State position and that concerns one of our particular groups in the Junior school, that is our "2" track, our slow-learner group. These groups do exist in some schools in South Australia, not all, but many, and there has been for some time a crisis regarding the availability of materials. We cannot wait for this Project to provide materials at this level.

One of the products of a grouping situation is selection and segration of minority groups and one of the results of the set-up of this Project has been the provision of materials for a small group of very difficult people to accommodate. The provision of materials for this group has become quite unattractive for the usual people who produce materials, for all sorts of unhappy reasons, and I would just like to underline very lightly the fact that ASEP's existence has made this provision of materials, the servicing for these people, even more difficult because it leads into what I am going to ask you to consider.

Knowing that we cannot wait for the normal event of the Project to produce materials for these people, knowing that these people do exist, and that they have been herded together in some schools in South Australia, we have to do something about it. We have to produce materials, or at least initiate their development. I would ask you as a Conference to consider what your reaction would be to a proposal from South Australia that we negotiate with ASEP for the development of materials in this area.

The statement that I want to make is this. After this Conference and after further discussions in South Australia to define our position a little bit more clearly, we will be making an approach to ASEP for assistance for the development in South Australia of materials for these "2" track slow-learner people. I think the important thing is that this will make some demand on the Project's resources. It may also contribute to the Project in some ways because, obviously, whatever we did produce would go into the fund of their experience or their resources.

But, with that point, I would like this matter to be given some discussion later on, and it simply remains for me to say that we are (as I have said about 7 times) confident that this Project is going in the right direction. We would like it to lay things on the line and be quite clear about its intent at this stage, but we have a very great deal of confidence in the Project staff and the work that they are doing.

Mr Eldridge - Tasmania

I am in a delightful position. Everything has been said at least once, or more often. I have already said most of what I want to say; the Statement came up two or three days ago, but it was not entirely intentional. There are one or two points I would like to make with respect to this.

First of all, our School Board situation is not quite the same as that anywhere else, and I think in order to explain why I say the things that I am going to say in a moment I had better say something about the Schools Board.

The Schools Board at present is a Certification body mainly. It no longer has control over what goes on in the schools, as it has done in the past. It has control over the Certificate at the end of four years and also at the end of 5 or 6 years of secondary schooling. The university accepts or rejects that Certificate for matriculation purposes, but the university is no longer the Certification authority at the matriculation level either. The Schools Board Certificate is issued after 4 years and another one, a Higher School Certificate, after 5 or 6 years. This gives it a certain advantage in that the whole thing is handled by one body.

We have the other advantage in change-over in the last year or two, in that since the Schools Board is concerned only with the final certificate, there is a lot more freedom and autonomy within the schools, particularly for the first 4 years.

Admittedly, for the last 2 years, since matriculation is in the sights for most of them, the situation really has not changed very much, although a different body is offering the certificate; but in those first four years, there is a tremendous amount of freedom.

The first part of the paper that I put out was headed "At Present" and indicates the courses that are offering in Tasmania now, and there is a tremendous selection as you will see. One of the things that I omitted from it was that we have had 5 schools working with JSSP, some of them since the Project began. So that is an additional complication to the lot that is there already.

Well, that lot is being discarded, as such, and a new course is in the process of being written; I should say a new syllabus is in the process of being written. We are rather firm on this fact that it is a syllabus that is being produced and not a course of study.

Again, the syllabus is being put out by the Schools Board on request of the Education Department specifically. The Schools Board, for Certification purposes at the end of 4 years, that is the end of grade 10, will accept any reasonable course and offer a certificate for attainment in that course. I would say a system of moderation is necessary to make sure that attainment is reaching a certain level.

The Education Department has requested the Schools Board to put out what it considers to be a satisfactory science course. The Schools Board has pulled in a group of people, mainly practising science teachers or at least members of the Science Teachers' Association, who are pretty closely related to the school situation. We are putting out a very open syllabus, along the lines that I have mentioned in my paper. We are looking at major areas, that is classification, structure, energy, equilibrium change and we are attempting to structure it in that way, keeping man and the environment as a sort of central feature.

Now what we want of the Project is material that we can use within that very general area. Obviously, we are not in that way demanding anything very specific, not demanding any specific sequences. I think the situation is flexible enough to accept anything that might be put forward in the spirit that we have been talking of this week.

The autonomy goes right down to the schools themselves and it is pretty genuine. Our allocation of time is a little bit less than has been mentioned in some cases, but this again is somewhat free within the schools. The Education Department can apply some sort of a limit there and has indicated one, but I don't think it is a very rigid one.

The main requirements that we have then are firstly, material. I think this is an overriding one. This came up pretty firmly yesterday. (Material very easy to satisfy is going to be restricted there very much.)

The second thing that I think we would want is communication. This has also been mentioned earlier.

We would like to know what is going on in pretty topical fashion. We would like a statement, as another State wanted a statement, of the outcomes of this Conference, something to go back to the schools, back to the Department, back to the State Advisory Committee immediately, if not sooner.

The third thing we would like is a pretty good running commentary on progress. I would like not to be misunderstood in my stand yesterday evening on the pilot scheme, and where the pilot scheme should be operating. We don't want to be left out of this obviously; I don't think anybody does. I was concerned then mainly with mechanics for keeping the first trial as simple and efficient as possible. We certainly would like to see that first trial material. If possible we would like to use it, like to offer our comments on it, but may be not in the first rank for reference.

The other way in which we would like communication is using ASEP as a sort of clearinghouse for curriculum information. I think there is a tremendous amount of material about; some people get to know about it, some people don't. I think it would be an extremely valuable function of ASEP, particularly during these first two or three years (after all we are only funded for a certain length of time), but possibly to institute a procedure like this which could be continued, could go on and on. There is not much, apart from the sort of voluntary efforts of the Science Teachers' Association, to disseminate information on new science developments, science materials and so on within Australia, and I think perhaps this is something that ASEP could start, even if it could not carry it on beyond the funding limit.

One or two minor points. There is an increasing tendency in Tasmania at least to set students. This means that the students within a given school and given year may all be doing science at the same time.

Now this has caused a bit of strife with JSSP because you can't make one box stretch over two rooms - not very easily anyway. We would like this to be borne in mind. One suggestion made on the basis of the JSSP-type material was that it might be possible to follow a sort of plateau system where you develop certain skills. This might require multiple supplies of boxes, then you reached a plateau on which you could use these skills in several different units, so that you would not necessarily have all classes doing the same unit together on that plateau. Maybe you have a box 1 which develops certain skills.

You might then need three or four sets of box 1, but then boxes 2, 3, 4 and 5 would all use those skills, so you would only need one box of each of those, and they could be rotated between those classes that were operating at that skilled level. If that is possible or not I don't know, but it was a point brought up by the Advisory Committee and certainly this difficulty of setting is one that I think is worth remembering.

We are committed to an emphasis on Man as part of the Environment. This has been mentioned several times during the week, but I don't think it's going to cross anybody's lines.

One other point on organization is that complex lab. work has been another point about JSSP that has caused some trouble. I think this is going to be worse in the near future, because I can't see our supply of science teachers improving.

Many teachers outside the science field are going to be called upon to operate with the classes, particularly in grades 7 and 8, if not 9 and 10 as well, and the supply of lab. technicians, I imagine, is not better in Tasmania than it is anywhere else. Most of our schools have a lab. technician. He may be somebody shared with general maintenance, with the workshops as well. He may occasionally be pressed into service as a science teacher, as has happened on one or two occasions. So we would make a plea for a fairly careful look before complicated, complex sets of apparatus are designed for particular units. Here again, obviously, it can't be allowed to cut back the efficiency of the whole thing, but I think it is a point that should be borne in mind.

I don't think that there is much else that I would like to say, but I would like to echo what John Mayfield said right at the end of his talk about the slow-learner.

The slow-learner is not adequately catered for by the present JSSP materials. This was a point brought up by all of the members of the Advisory Council who are JSSP teachers. There is an awful gap down at the bottom of the line there which we haven't been able to fill adequately. We couldn't quite put our finger on why it was and how we could cure it. I don't know whether it could be cured with the present materials. It seems to be very largely a matter of reading ability. It may be possible to put out material, but this is a point for investigation, presumably, in an almost pictorial form. These are for the comic readers, so couldn't we approach the problem along those lines, if necessary, almost non-verbally?

I think there is a good 10% of the school population that is likely to find itself in something approaching a remedial class. I think it would be extremely sad if we didn't meet them in some way. Maybe it is not within the main theme of ASEP, but I do support John in his plea for a consideration at least of this bunch down at the bottom.

Thank you very much for a most enjoyable time here. I have another day to go, but it has been extremely pleasant and I am sure that we can co-operate.

# "THE STATES AND ASEP" - TASMANIA

## At Present

Two years General Science (no major modification for some years - subdivided into disciplines) are followed by two years in which there is a very wide choice:

a) Chemistry, Physics, Biology, Geology as separate sciences;
b) Science IIIA (any pair of the above sciences);
c) Science IIIB (General Science with Physics emphasis);
d) Science IIIC (General Science with Biology emphasis);
e) Science I or II (General Science developed from first two years' course).

Certification: The Schools Board issues a School Certificate after an internal assessment, governed by moderation at school, region and State levels.

## Present Developments

The Schools Board, at the request of the Education Department, is developing a single Science syllabus. It is an integrated syllabus, having as its major themes: structure, classification, energy, change and equilibrium. Man is viewed as an integrating factor. This syllabus will be made available to schools for course development. It is likely that the Education Department will offer a possible course for schools who wish to use it; but it is an important feature of the proposed system that there shall be considerable autonomy within the schools.

Schools may offer other syllabuses to the Schools Board for approval. Nuffield Chemistry and Physics have already been so offered by private schools. (State schools will have to design their courses on the Science syllabus if it is accepted by the Department).

The following statement from the Trial Science Syllabus for School Certificate of The Schools Board of Tasmania may give some indication of our views on science education in the junior years.

Science is a search for truth leading by induction, deduction and verification to an organised body of knowledge which stimulates further search. Science requires careful observation and logical argument from well-established factual and theoretical bases leading to predictions which must be objectively tested. Application of knowledge so obtained allows man increased use and control of the material environment.

Personal involvement in science should lead the student to application of the scientific method in his own search for truth and in decision-making, to an understanding of the forces operative in the material universe and their interplay and of the way in which such forces may be harnessed to the benefit of mankind. Such involvement should stimulate curiosity leading to continued professional or informed lay interest in and evaluation of man's increasing knowledge of natural phenomena.

## THE AIMS OF EDUCATION IN SCIENCE

**Knowledge:** The student should acquire that scientific knowledge which enables him to gain the most fruitful understanding of his environment including himself as part of it .

**Skills:** The student should develop skills necessary in a scientific search for truth. These skills are concerned with careful observation and accurate recording, with correlation, with the recognition and clear definition of problems, with prediction, with design and conduct of experiments.

**Attitudes:** Science studies should influence the student's approach to problem solving by encouraging persistence, the practice of seeking evidence and of withholding judgment until evidence is available, imaginative thinking and the critical appraisal of theories and explanations. They should also lead to an appreciation of the impact of science on our society and to the formation of soundly based attitudes to the conservation of our total environment.

**Interests:** The natural curiousity of the student should be guided and encouraged so that lifelong interests, beneficial to the individual and to society, may be developed.

### State Advisory Committee comments on ASEP

1. The freedom provided in the Schools Board system should not be curtailed by a rigid course of study.
2. The present JSSP system is fairly satisfactory for grades 7 and 8.
3. Research activities give freedom and flexibility.
4. If the material is to be available to all students it may be desirable to present it at two levels of reading difficulty.
5. If the essential material is presented early in a unit there is not so much urgency in completing the unit.
6. Differences in ability become more marked in grades 9 and 10 and a multiple approach may be more necessary. There could be a deeper, narrower, more quantitative course for the more able.
7. A change from the card system seems desirable for the higher grades.
8. Subject approach might be through 'sequences' or 'nets' of topics but should emphasise man as part of the environment.
9. Cognisance must be taken of the science taught before grade 7 and after grade 10 (particularly the former).
10. An adequate system of trial classes in all types of situation should be carried out initially, with full feed-back for modification and adequate facilities for concurrent discussion.
11. ASEP should be responsible for initiaion of pilot teachers, preferably also run introductory courses thereafter.

# ASEP

## STATE ADVISORY COMMITTEE FOR VICTORIA

### SUMMARY OF OPINION

1. Purposes of Project are fully supported.

2. Provided it is consistent with the objectives of the Project, the preparation of material at the Forms III and IV level could receive priority, since the existing JSSP materials are available in all States. Alternative materials should be developed in due course at all levels to ensure flexibilities.

3. ASEP should actively encourage the development of alternative materials by other bodies, and the Project's materials should specifically refer to other sources to encourage consideration of them.

4. Materials should be designed to accommodate a wide variety of approaches, to allow for a high level of student initiative, and to provide for individual differences in ability and interests.

5. Courses should be based on the needs and interests of students, and not be substantially influenced by the content of higher academic studies.

6. The Project should develop materials specifically designed for outside-the-class activities, and to encourage related hobbies.

7. A complete range of test materials should be available. These should not be restricted to assessing cognitive progress, and should include frequent brief diagnostic tests with correlated remedial materials.

8. Evaluation guidelines should be prepared for teachers to encourage them to develop their own procedures for assessing the effectiveness of the learning situations provided.

9. There is a need for a wide range of materials for the presentation of subject matter, including those for individual student use, such as film loops, transparencies, and small programmed units.

10. A system of regional consultants and district materials centres would be valuable.

11. There is need for inter-State cooperation in such fields as audio-visual aids.

12. The Project should involve a great many teachers in the planning and production of teaching materials, encourage feed-back, and endeavour to keep all teachers involved and fully informed.

13. In-service training is considered an essential element to the success of the Project.

B. Rechter

# IMPLICATIONS TO THE NATION

I do not intend to interpret my brief too literally. The implications of the ASEP project for the Nation are difficult to fathom at this early stage of good intentions.

Instead I propose, in counterpoint to the comments expressed by the chairmen of the State Advisory Committees, though not I hope in contradiction of them, to take up some of the implications which seem to me to follow from the fact this is a National, Australia-wide co-operative effort and, hopefully the first of a number of such projects in education.

It is worthwhile briefly to start by examining a contrasting model for curriculum development - that of the science projects in the USA.

This is particularly apposite at this point in time, for we have recently been flooded by a plethora of surveys of the decade 1960-1970 from every conceivable ange; and the period of new curriculum developments in American Science coincides with this decade.

The pattern of US development has in general been one of private-group initiative, funded either by a Federal Agency or by a private foundation. Most important, despite occasional government funding, the project organisations which were established had no direct or indirect responsibility to any State-wide or local educational bureaucracies, using that term in a purely descriptive sense).

The materials produced had to compete, against those existing already and usually were handed to a commercial firm for publication, a firm which made it its business to advertise their virtues as widely as possible.

The result was a very uneven development of the use of the new materials. Some, like CBA, had limited and even localised success, others spread more widely throughout the country. The US man in the BSCS office with its little flags showing areas of activity, had some very bald patches, notably in the Southern States.

While the training and indoctrination of teachers in the use of new resources tended to be based on relatively limited budgets, (by American standards at least), the form it took was based on enthusiastic volunteers representing a thin sampling of teachers from the vast numbers of school systems. This made it difficult to introduce the courses in many areas with experienced teachers. Romey, on his visit last year indicated the dissatisfaction of the E.S.C.P. with such a haphazard approach to teacher induction and indicated an approach which involved a kind of exhaustive and mass teacher training programme for all teachers in a particular system who will teach the course, so that a whole school area might begin to use the materials of the particular project.

When we turn to Australia it is rather difficult to speak of a pattern emerging from examples of a number of different projects comparable in size, expertise and sophistication to the American ones to which I have referred. To date the only comparable exaple we have in this country is ASEP itself. Nevertheless it is perhaps worth analysing some of its features and their implications.

Compared with American projects, this is a National one in a peculiar sense. Primarily, it is funded by the National government and this funding has been augmented by all the state governments. Secondly the states and the commonwealth are linked here in a joint venture. Furthermore the independent and catholic schools are linked with the government schools by means of the Boards of Studies and examinations in all states.

The consequence of all this is that this project is deeply embedded in the whole structure of the Australian school system.

It seems to me that if the Australian structure I have briefly described is to be, for whatever reasons, the model for future developments, we need to be very critically aware, both of the possible constraints this might impose and of the very solid advantages it might confer.

We need to look at these constraints and advantages insofar as they operate on the development of the project materials, on the incorporation of the materials into the classroom learning situations and not least on the preparation of teachers to handle the new materials.

First then, the development of the materials. In every State system of education radical changes in courses of study and examinations are in progress or will be in progress in the next few years. A possible constraint might therefore arise if, in the area of science such changes result in a firming of positions resulting in an attitude to ASE of selecting from the ASE materials what is congruent with the fixed requirements and neglecting the rest.

One can accept the belief that each state, as a result of a specific history and tradition, may feel that it has particular and specific needs in Science education which must be catered for. Given such a situation it seems to me imperative that those responsible for secondary science education in each state system see the next few years as a period of intense and cooperative effort with the ASE Project, to formulate new courses of study, not by fitting ASEP products to previously fixed patterns, but by a progressive process of change based on the very fact that a major National effort is underway.

This is far from being a plea for a uniform Australia-wide course of science study. I would not like to bite the hand that feeds us, but I believe that the only references to standardisation and uniformity relating to the project date back to the very beginnings of the approaches to the Federal Government and were made with only a naive appreciation of their educational implications.

What is needed is probably not even state-wide fixed courses in which every classroom goes through the same process. But that is not the issue at the moment, although hopefully, the officers of the project might be able, in the cooperative process which I've described, to persuade course constructors of the importance of variety and attention to individual differences. My reaction to the intention at least of the views expressed on this matter by State representatives at this conference is a one of great optimism.

So much for the development of materials. What are the National implications of the need for an effective and rapid introduction of these materials into the classrooms? This of course is looking rather far ahead, but if we start concerning ourselves with the problem now we may be able to achieve our objectives. Again each state has its own traditions and procedures on the provision of materials for schools and classrooms though one common element in the government sector at least is a scarcity of resources which shows no sign of abating in the next ten years. In particular, can we ensure, if the materials are as good as we believe they will be, and in the light of our discussion on Tuesday of compensating for socio-economic deprivation, that all children will have access to them?

It is my opinion that we should begin to make clear that only massive Federal financial assistance based on the same model of cooperation with the State departments of education, can make possible a condition in which ASEP material will reach all the schools in this country. It is perfectly obvious that the Commonwealth involvement in secondary education will increase in this decade. If we accept the fact that all Australian children in the Junior Secondary years should study science and in a meaningful way we should not as science educators and teachers regard the issue as closed when the $1.2 dollar is spent, and the material is published. We have an equal responsibility to work for its effective availability to all children in secondary classes.

The third issue I want to take up is that of Teacher Training. Our own experience with the introduction of the Web of Life Course, P.S.S.C. and the NSW Wyndham Science course, has strongly reinforced the views we have heard from the USA and the UK on the primacy of teacher preparation in making a success of new courses. The opinion isunanimous that both in the course of production of the materials and later this is an area of vital importance.

Obviously we can rely on the cooperation and support of teacher training institutions, faculties of education, departments of education and science teachers' associations in this problem.

Yet again however, it will be impossible for these agencies to provide sufficient resources from their normal funds for such activities to be effective, particularly if we follow the desired model of ensuring exhaustive (and exhausting) induction of teachers in various regions rather than a piecemeal selective approach. The Commonwealth has been very careful in its entry into teacher training for evident reasons, but only Commonwealth funds, liberally disbursed can meet the needs, and such funds will not be forthcoming unless there is an informal climate of opinion in Australia that they are needed to complete the task just begun.

I suppose what I have tried to say is that the National implications of this first small step are firstly a far greater level of detailed cooperation by science educators and science teachers than hitherto (one might add that if this conference is an indication, the process might be enjoyable as well as fruitful.) Secondly, I cannot see any alternative to a greater involvement by the Commonwealth Government in secondary education in the 1970's if the initial spending is not to be frittered away. There are many possible models for such involvement, but we have the responsibility to test this one out, and see that it works.

B. Rechter

# AIMS OF ASEP

## FIRST DRAFT

The following statements represent a synthesis, compromise, summary, elaboration, or work of fiction purportedly stemming from summaries of documents generated on Monday and Tuesday evenings, and the discussions of Monday evening. It is suggested that this statement be the ba sis of discussion of this issue on Thursday afternoon. Delegates favouring a major rewording of parts or the whole are asked to bring their alternative statement - preferably prepared in multiple copies, to the meeting.

Extracts from various documents which are relevant are appended.

Best Avialable

# AIMS OF ASEP

1.1 Science education can and should contribute to the personal development of the individual in aspects of social responsibility and by contributing to the achievement of greater self-reliance, independence, flexibility and creativity. The programme should embody experiences which lead towards the development of the child as a social being.

1.2 The pupil's immediate environment and interests should be one important determinant guiding the types of materials selected and the methodology employed. For some students the immediate environment and interests are the appropriate starting points of certain topics. For some students and for some topics the materials should stem from the creation of a relevant environment and the stimulation of new interests.

1.3 The programme should be concerned with preparing students to take their place in future society and to make a responsible contribution to it. Future needs should be met by suitable experience of present trends and changes.

1.4 Science is both a structured and dynamic body of knowledge and an array of intellectual skills by which this information is obtained and interpreted. The big ideas and the major processes of science should be basic determinants of the content and the range of instructional procedures, of the programme. These two dimensions are of equal importance, but the balance between them and their relationship to the other major aims of personal and social development and relevance to the students' immediate environment may change from stage to stage and may be different for students of different ability. The final balance should emerge from the development of the programme.

1.5 While the traditional disciplines do exist and represent meaningful divisions in content, we do not believe that the separate disciplines should be the basis of the structure of the programme. We believe that important ideas and methodologies are interdisciplinary and will emerge from an integrated approach directed towards giving the student a unified and structured understanding of his environment.

1.6 The requirements of a science project at this level should not be determined by the demands of higher education. The programme should be determined by objectives appropriate to students at this level. Cognizance must be taken both of the needs of the majority of students for whom the course is terminal and of the needs of those students form whom the course is a preparation for higher study.

## RELATED STATEMENTS

Q. What is the importance of the great body of scientific knowledge and processes in the development of pupils from grades 7 thru 10?

1. Whatever approach is used, the pupils will end up with a great body of knowledge in any science course. This will not necessarily meet all of the State requirements, but States can omit or add to ASEP to meet their own requirements.

   Pupils should gain sufficient data to help them to make informed decisions in areas related to science.

2. Selection of the topics should be on the basis of important principles of science; and that the quality of social responsibility should be added to those of autonomy and self-direction. The Project must make decisions about what the pupils shall learn, i.e. about content. One fundamental aim of the Project is to ensure that the pupils understand this selected knowledge. This does not mean that all pupils attempt to attain the same knowledge objectives or that they progress at the same rate. The knowledge is selected from the general body of knowledge contained in the scientific disciplines. Many criteria are involved in this selection. Whether material is "relevant, interesting or meaningful" the child is not the sole criterion for this selection.

3. This is the unique contribution that science teaching can make.

   A basis for factual content is necessary, but the choice of such content is less important than that a few powerful ideas of science be presented. Doubt was expressed by a minority as to whether these powerful concepts are the most important things for teaching science in grades 7-10.

4. The aquisition of a substantial body of scientific knowledge is not a prime aim of the Project but some of this knowledge sho be readily accessible to students when they embark on individual exploratory experiences.
   The students should be able to recall a sufficient number of concepts and principles (to be determined by the Project) and to acquire a suitable vocabulary to have access to and to communica about the "great body of scientific knowledge".

Q. What are the criteria for selection of the Science linked experiences that constitute the subject matter of the matter?

1. Some of the criteria on which material should be selected are:
   - Processes of science.
   - Development of social skills among children.
   - Content should be directed towards achieving some structure of knowledge.
   - Personal development of the student (independence, creativity
   - Relevance to a child's interest and environment.
   - Maintenance of the child's interest.
   - Appreciation of the way in which man has changed his environment.

2. The subject matter of the Project should be concerned with attitudes of students, manipulation of equipment and materials, science content, environmental applications of science, the extension of knowledge, the use of science processes, and should be consistent with the structure of scientific knowledge. Project material related to the pupil's environment should predominate.

   (a) Consideration should be given to learning theories as criteria for selection of project materials.
   (b) Materials should promote awareness of an integrated

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[illegible] of new 'big [illegible]

[illegible] with other areas of [illegible].

[illegible] of enquiry to life [illegible]

[illegible] group learning or [illegible] interaction become [illegible]

[illegible] should be concerned with [illegible] grandeur of the universe, the [illegible] fallibility of man and the universal nature of scientific study.

[illegible] to state criteria. However we do [illegible]

[illegible] in selecting subjects [illegible] subject-matter.

[illegible] experiences on the basis of [illegible] is one method of [illegible] of science-linked [illegible] interaction of "Scientists", [illegible] 'practising teachers' on a [illegible] prove a more effective [illegible]

[illegible] on pilot tests.

[illegible] PAPERS

[illegible]

Knowledge: [illegible] scientific know[illegible] fruitful understanding of [illegible] of it.

Skills: [illegible] skills necessary in a [illegible] are concerned with [illegible], with correlation, [illegible] of problems, with [illegible]

Attitudes: [illegible] the student's approach [illegible], the practice of [illegible] until evidence is [illegible] critical appraisal of [illegible] also lead to an appreciation of the [illegible] society and to the formation of soundly based [illegible] to the conservation of our total environment.

Interests: The natural curiosity of the student should be guided and encouraged so that lifelong interests, beneficial to the individual and to society, may be developed.

Differences in ability become more marked in grades 9 and 10 and a multiple approach may be more necessary. There could be a deeper, narrower, more quantitative course for the more able.

Subject matter might be through "sequences" or "nets" of topics that should emphasise man as part of the environment. Cognisance must be taken of the science taught before grade 7 and after grade 10 (particularly the former).

Best Available

## WESTERN AUSTRALIA

This committee considers a curriculum most likely to achieve these objectives as that which embodies instructional procedures with the following characteristics.

1. The curriculum should be a balance between the inductive and the expository directions of teaching. Students should participate in meaningful enquiry based on laboratory and field experience.

2. The curriculum should be structured around the major concepts of science. There should be a sequential development of a few powerful ideas rather than a detailed survey of the information of science.

3. The curriculum should incorporate the structured development of the processes of scientific enquiry. Students should learn in a systematic way the skills of obtaining, organizing, interpreting and communicating scientific information of designing and conducting experiments.

4. The curriculum should foster the systematic development of independent study habits and enquiry skills. As the student builds an increasing store of information and process skills, the materials should tend from highly directive towards open-ended enquiry.

5. The curriculum through its instructional materials should capture student interest and carry a high level of intrinsic motivation. This further implies that the demands upon the child be related closely to the child's experience and to his level of cognitive development.

6. The development of process skills and powerful ideas should be spiral so that the student applies the same skills and ideas in a number of different contexts, thus favouring retention and transfer into novel situations.

7. The committee believes that sound instruction is hierarchical with each unit building on the outcomes of preceding units.

## VICTORIA

1. Materials should be designed to accommodate a wide variety of approaches, to allow for a high level of student initiative, and to provide for individual differences in ability and interests.

2. Courses should be based on the needs and interests of students, and not be substantially influenced by the content of higher academic studies.

3. The Project should develop materials specifically designed for outside-the-class activities, and to encourage related hobbies.

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[illegible]

## [illegible] SESSION - THURSDAY

This session will be divided into two sections covering two different topics:

- i. Questions arising from the Thursday morning topics and related questions.
- ii. Consideration of the First Draft of the Aims of ASEP (See page 4 below and the draft document already issued.)

The decision concerning the allocation of time to these two sections is left to each syndicate, but it is suggested that perhaps half the time be devoted to each section.

### Section I

For this section there will be no further plenary session. The recommendations from the syndicates will be passed direct to the special syndicate considering these questions on Friday morning. This syndicate, which will be representative of the six states, will collate the recommendations for submission to the final plenary session.

Seven "priority questions" are listed in this section together with three further questions. Syndicates should select those questions on which they feel they can make a valuable comment or on which they wish to present a particular view.

1. What should be the relationship between state courses of study and the development of materials? To what degree will, and should, either one impose constraints on the other?

2. For what grade or grades should the first ASEP materials be developed? (Ref. Mr. Howard's paper, para. 6.4-6.6)

3. (a) Should the project aim to decrease differences between curricula:
    (i) between states?
    (ii) within states?
   (b) Should it aim to increase them?
   (c) If "Yes" to either (a) or (b), how might this be achieved?

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[illegible] What [illegible] be [illegible] for entry of first year secondary [illegible] at [illegible] grade 7 and grade 8 [illegible]

[illegible] the role of existing curriculum materials?

b) What should be the relationship between ASEP and other curriculum projects?

c. Will the existing organisation and plans provide adequate opportunities for inter-state cooperation?

What further provision should be made?

Should [illegible] planning be extended to other areas e.g. teacher education and the provision of materials to schools?

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Further Questions:

8. What allowance should be made for variations in the number of periods per week allotted to science?

9. What allowance should be made for variations in science background resulting from different science education at primary level?

10. In providing materials in biology and geology, to what extent can and should the project cater for regional differences?

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## Session 11

## Consideration of the "First Draft of the Aims of ASEP"

Discussion should be based on the "First Draft" prepared following the discussions on Monday and Tuesday.

Other relevant documents are:
- (i) the materials attached to the First Draft.
- (ii) Mr Howard's statement of the purposes of ASEP, esp. paras. 4.23-4.27 (page8)
- (iii) The relevant sections of documents produced by individual members of the conference.

Comments or proposed amendments should be listed under, and related to, the six sections of ~~the~~ First Draft.

1.1

1.2

1.3

Best Avialable

|  | Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|---|
| 1. | Continuous contact should be maintained between ASEP and the states concerning purposes, objectives and outcomes. State courses of study should not impose restraints on the project's overall aims and objectives. Plan for development of the four year course should be made known to the states as soon as possible. | State courses of study, should in no way, constrain the project. The project may see fit to study different state courses in order to obtain a guide to the sequential development of the materials.<br>No, there should be no constraints, but there should be interaction, between the project and appropriate state bodies. | It is hopes in view of trends to eliminate external esams. and give teachers more authority in the classroom, that the States' courses of study become more flexible and hence impose no restraints on ASEP materials.<br>All information pertaining to the Project should be made available to the States as early as possible to allow syllabus committees to take Project developments into account. | Inevitably, there will be interaction. |
| 2. | The group was in favour of beginning at the lowest level (majority of 8 to 1). | The entire sequence of materials should be planned as a whole or complete entity.<br>There should be no decision made at the present stage as to when the materials will be available in bloc. | Priorities:<br>(1)that a complete conceptual framework or master plan for materials be prepared.<br>(2)the first materials should be developed for the level where there seems to be the greatest need.<br>This group challenges para. 6.8, Mr.Howard's paper. | We agree with Western Australia Position Paper, page 1 - "Role of Existing JSSP Materials". Item 1. |

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 3. No comment | The Project should be concerned with producing materials that allow a wide choice of content and methodology. | Question not applicable. | We believe that the effects both between and within States, of Project materials as they are used, should be to produce both commonality and variety in student outcomes. |
| 4. Materials at these levels should show maximum flexibility and limited length of sequences. First level materials should not be too closely identified with any particular grade. The wide variation in number of periods allotted to science in grades 7 and 8 is considered to be as significant as the differences due to entry level. | If the materials allow for individual differences, in the way proposed, the question is inappropriate. | Overlap between the science content included at higher primary levels and lower secondary levels should be avoided. | School attendance. |

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 5. (a) 1.Where available other materials designed to achieve the same aims should be adopted(after modification if necessary).<br>2.Materials from other curriculum projects could provide alternative approaches.<br>3.Guides to teachers should contain information about other available materials.<br>(b) ASEP and other curriculum projects should maintain continuous contact.<br>This syndicate recommends to the executive that teams of people, outside the project staff, should be encouraged to develop materials for ASEP. In this way those people with special skills, e.g. writing for slow learners, could contribute at the development stage. In addition, under these circumstances, several versions of the same material could be produced by different and independent persons (given the same guidelines) so that the development staff could select from, or be guided by, these materials.<br>From the init. stages all teachers should be encouraged to submit ideas experiences or materials to the project on the basis that originators of acceptable items will be considered as consultants. | (a)They should be regarded, as a "bank of materials" that can be drawn on, as the Project thinks fit.<br>(b)The Executive uses its discretion to contract for competent people other than the permanent staff to work with the Project. | (a)Existing curriculum materials should be carefully scrutinized, ASEP materials developed from any aspects of these considered useful, but ASEP resources not wasted in developing materials which do nothing more than parallel already existing ones.<br>(b)There should be a free interchange of ideas and interaction between any curriculum projects and ASEP with the recommendation that ASEP headquarters act as a clearinghouse for the dissemination of information. Recommendation:The Project should identify areas for wh which it may not be expedient to produce materials, and encourage local or specialized development of materials for these areas by other bodies. | (a) 1. Source of information and ideas.<br>2. Supplementation of ASEP materials.<br>3. Adaptation of existing materials.<br>(b) Co-operation at the design stage should be encouraged; exchange visits are recommended. There are advantages to be gained from co-operation with other bodies or individuals developing materials, but such co-operation should further the aims of ASEP. |

Best Avialable

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 6. From the initial stages, teachers should be invited to participate in the development. (Refer 5 (b) ). | | Refer 5 (b). | Co-operation with syllabus-regulating bodies in all States should be promoted.<br>Interstate co-operation at the level envisaged when 3 States were involved is desirable with all 6 States, although this may envisage additional funding.<br>Advantage should be taken of opportunities provided by interstate conferences, e.g. CONASTA, ANZAAS, and professional journals e.g. Aust. Sci. Teachers' Journal. |
| 7. Additional Commonwealth finance should be sought for<br>(1) the education of teachers in the use of the materials after publication.<br>(2) the provision of materials to schools. | Recommendation:<br>The Project should formally raise the question of teacher education with appropriate authorities and ASTA for early consideration and action. | Yes. | The possibility of Commonwealth funding being extended to teacher education should be investigated. |
| 10. Essential, this provides an opportunity for interstate consultative advice. | | | |
| 11 | Teams outside Project staff should contribute material to ASEP. | Syndicate recommends people outside Project staff should be involved in development of materials.<br>Hence people with special skills can be included. | |

## AIMS OF ASEP - COMMENTS ON FIRST DRAFT

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 1.1 Replace with Noel Wilson's:<br>Science classroom experiences should contribute to the personal and social development of the child. In particular they should aim to develop<br>a balance between independence and interdependence in problem solving situations<br>a commitment to enquiry as one mode of operation in life situations<br>a willingness to adapt, to be flexible, in new situations. | General agreement. | Acceptod. | Agree. |
| 1.2 Accepted. | (a) ASEP must aim to cater for individual differences in its learning methods.<br>(b) The pupil's immediate environment and interests should be a guide to methodology, not to knowledge objectives.<br>Violent disagreement occurred between some members of the group. | Accepted. | Delete "[illegible]" in line<br>Change "relevant" b<br>"novel" in line 6. |
| 1.3 Accepted.<br>This section should be incorporated in 1.1. | Delete the second sentence. | No objection. | Agree with first sente<br>Delete other sentence |

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## AIMS OF ASEP - COMMENTS ON FIRST DRAFT

| Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|
| 1.4 Change to:<br>"Science is both a structured and dynamic body of knowledge and an array of intellectual skills by which this information is obtained and interpreted. The "big ideas" and the modes of enquiry in science should be basic determinants of the content and the range of instructional procedures of the programme. These two dimensions are of considerable importance, but the balance between them and their relationship to the other major aims of personal and social development and relevance to the students' immediate environment may change from stage to stage and may be different for students of different ability. The final balance should emerge from the development of the programme.<br>Minority opinions:<br>(a)"Big ideas" should include any major organizing theme.<br>(b)Disagree with "big ideas" if this term means "major conceptual schemes". | No agreement could be reached after long discussion. | This syndicate requests that time be given tonight to an explanation of the Vickery and Wilson versions of 1.4 which clearly delineate the differences. We would particularly like to hear the views of the professional scientists in relation to this. | Altered to read as follows:<br>Science is both a structural and dynamic body of knowledge and an array of intellectual skills by which this information is obtained and interpreted. The big ideas and the major processes of science should be important determinants of what is included in the programme. The balance between these two dimensions and their relationship to the other major aims of personal and social development and relevance to the students' immediate environment may change from stage to stage and may be different for students of different ability. The final balance should emerge from the development of the programme. |

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## AIMS OF ASEP – ~~CONCEPTS~~ COMMENTS ON FIRST DRAFT

| | Room 1 | Room 2 | Room 3 | Room 4 |
|---|---|---|---|---|
| 1.5 | Change to:<br>"We do not believe that the separate disciplines should be the basis of the structure of the programme".<br>The second sentence was deleted for reasons similar to that expressed in The Report of the Working Party on Secondary School Science - Science for General Education (Scotland) page 18:<br>"We should emphasize that we have not tried to integrate material in any artificial way. Where subject matter falls naturally together an integrated approach has been suggested, where this is not easily possible we have considered it better to deal with the content as a single discipline".<br>A minority opinion agrees with the intention of the second sentence. | Delete the last sentence, beginning with "We believe ....". | Sentence 1 approved.<br>Sentence 2 not understood (e.g. "unified understanding of environment"). | While the traditional disciplines do exist and represent meaningful divisions in content, we believe that the separate disciplines should not be the basis of the structure of the programme.<br>We believe that some important ideas and methodologies are interdisciplinary. |
| 1.6 | Change "demands" to "requirements", otherwise acceptable. | Delete the last sentence beginning with "Cognizance must be ...." | Both versions (Vickery and Wilson) acceptable. | Agree, with last sentence changed to read as follows: "Cognizance shou be taken of the needs of all studen |

1.7 To develop in both pupils and teachers the power to initiate and develop their own enquiries, both individually and cooperatively.

# RESULT OF PLENARY SESSION - THURSDAY

## (Discussion of Rationale)

1.1 General agreement with both statements (First Draft and N.Wilson). The clarity of expression in the Wilson statement was seen as an improvement but all parts of the First Draft statement should be included.

1.2 General agreement with the first sentence of the First Draft statement.
The second sentence amended to read:
For some students their familiar environment and immediate interests are appropriate starting points of certain topics.

There was disagreement about the word 'relevant' in the third sentence.

Votes for relevant II
novel II
relevant new II

For re-drafting, the use of 'and' in the last line should be considered. (possible alternative 'and/or')

1.3 A majority wished to delete the second sentence.
A minority of 7 or 8 felt strongly that there should be an attempt to develop a second sentence incorporating the underlying ideas of the existing second sentence.

1.4 A vote was taken on the question of including 'big ideas' in its present form.

17 voted for its retention
11 voted against with a number not voting.

Dr.Radford suggested that the group should give examples as illustrations for terms used.

Apart from these points, no firm recommendations were arrived at during this session.

FOOTNOTE: Would the group decide whether the science content should be the over-riding criteria in the selection of material. (L.Dale)

1.5 Recommend statement from Room 4.
If possible, it should be expressed in a positive form.

Attention drawn to comment from Working Party Report (Room 1).

1.6 Recommend the original statement (First Draft) and the last sentence changed to:
Cognizance should be taken of the needs of all students.
'The requirements' in line 1 should be changed to 'The nature'....
Suggestion: 'The demands of higher education' should be replaced by some other term.

1.7 A majority recommended that this be included as a separate item with a small minority voting for its incorporation with 1.1.

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1.8 A separate general statement of an aim relevant to individual differences should be drafted.

FOOTNOTE: Could the statement be expressed as an aim? (Dr.Ramsey)

Notes from Chairman

1. The material postponed from Tuesday to Thursday was not dealt with and should be considered by the final syndicate.

2. In my opinion this is not a statement of aims but a series of statements from which a statement of aims might be drafted. In the original discussion on Monday the syndicates were asked to consider the importance or role of six separate factors in determining the goals of science education. They have therefore in effect produced the answers to six questions, not a set of aims.

# A CRITIQUE OF SOME BASIC ISSUES

by D. H. Bennett
M. L. Turner

We wish to register our objection to the proposal that the documents of the conference should include a statement to the effect that the project should mount some kind of supplementary operation to provide "Compensatory education" for certain special groups. Our reason for this objection is that we believe that those elements included in the philosophy of compensatory education which are worthy of support should form the basis of the philosophy of the whole project and therefore any statement such as that proposed would imply that this is not so. If the project is to be worthwhile, it should aim to raise the initial "levels of ability" of *all* pupils at *all* "levels", irrespective of the factors which have caused the initial differences in performance. *This will necessarily involve providing individual pupils with the experiences which they have not yet had*.

To add a statement demanding "compensatory education" for certain groups of pupils would imply that much that has been presented in the executive's proposals would be either meaningless or open to an undesirable interpretation. This applies particularly to the many references to individual differences and to stages of development. There are basically two approaches to "providing for" individual differences. One approach assumes that the pupil's initial level of ability, in particular, his initial capacity to learn, *will not change significantly in the future*. It assumes that a pupil whose initial capacity to learn is limited will never be capable of achieving the goals set for some other pupils, and therefore that all that can be done is to provide him with material which is "interesting", "meaningful" and "enjoyable" to him. It thus matches goals to the individual (cf Cronbach - see Turner, page 4). The other approach lays stress on initial differences in ability because the aim is to raise those levels. How these differences arise is from this point of view immaterial, although it is known that previous experience plays a major part in creating these differences. Therefore *most if not all* pupils must be provided with at least some experiences which some other pupils have previously had. Pupils with a poor environmental background must of course be provided with a great many experiences (of all kinds) which other pupils may have had years before. The essential aim is *to increase the pupil's capacity for further learning* and therefore to increase his capacity to understand and "cope with" the environment. To do this it is necessary to make a deliberate effort to ensure that he acquires the knowledge - concepts, principles, "facts", etc. - and the skills and attitudes he lacks.

The choice between these two approaches to individual differences is crucial for the Project. For example, why should material be provided at different levels of reading difficulty? According to the first approach, the assumption is that the pupil can be expected to remain at a particular level or, at least, *that the project will do nothing to ensure that he doesn't*. The second approach provides each pupil with material at a suitable level *in order to* improve his reading ability - for example, by increasing his range of concepts. Therefore it does not merely allow the individual "to change his level if necessary". It assumes that the difficulty level of the material which *any* particular individual will require will increase *as a result of* the work of the Project. If not, the materials are not successful. It is obvious that the design and content of the materials in the two cases will be quite different and also the behaviour required from the teacher.

Similarly, if pupils do not possess the attitudes required for further learning, then it should be an important aim of the Project

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to ensure that they acquire them. While recognizing that our success in achieving this aim will inevitably be limited, we should explicitly reject the view that because of these or other characteristics, the pupil *will not be* among those who will wish to or be capable of, higher education. One important measure of the success of the Project would be the degree of which it increases the proportions of those who wish to proceed to higher education, and of those who are capable of doing so if they wish.

Again, why should we adopt the model of the three "stages of development"? If we accept that adults differ greatly in their capacity for logical, abstract thought - that some make the transition from the concrete operational stage only to a limited extent, then we can draw one of two conclusions. We may say merely that because some pupils belong in the abstract stage, some in the intermediate stage, and some in the concrete stage (reinforced or otherwise), we must provide enough material "suitable to" each of these three stages. Or we can say that it is a primary function of the Project to promote the transition from Stage 1 to Stage 3 (to increase the pupil's capacity for logical, abstract, "scientific"(?) thought) and that the function of *every* pieve of material will be to assist this transition. Although all pupils would benefit from this approach, it is essential for those who, probably due to less fortunate home background, have not yet made this transition. Thegreater the pupil's poverty of past experience, the more effort the Project must devote to this end and the greater its contribution will be towards "compensating for" previous factors in learning - past and contemporaneous - over which the child has no control.

We know that "socio-economic factors" are *for all pupils*, the main variables determining initial differences i n ability. Therefore, if the Project is in fact based on the philosophy we have outlined, it would be absurd to add a rider that some special provision should be made for some particular group of children affected by these factors. We therefore support the spirit of the arguments advanced by Peter Fensham but not the form in which they are made. In order that the position of the project on these points should be made quite clear, we propose that a statement such as the following should be included in the conference recommendations:

"A fundamental aim of the Project is to increase the learning capacities of all pupils, irrespective of their levels of ability when they enter the secondary school. Considerable emphasis will be placed on individual differences in order that this aim may be as far as possible achieved. The Project thus hopes to make the maximum provision for the great range of differences in previous experience and learning of pupils entering our secondary schools. Considerable effort must be devoted to providing learning experiences of the kinds required by those pupils whose past background of experience has usually for socio-economics reasons been limited, and to ensure that these pupils develop their capacity for logical abstract thought and for rational analysis and argument, and those intellectual skills and attitudes characteristic of science".

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## II.

We feel that the proposals presented to the conference by the executive of the project contain a disturbing emphasis on selecting material and experiences which are "meaningful", "interesting" and "relevant" to the child and "within his immediate experience". (See e.g. Howard, paras. 4.6; 4.7; 4.27; Dale, Section B). These are proposed as crucial criteria for the selection of content for the materials, and as such we do not believe that they are either valid or useful.

If these statements were to mean merely that the material selected should be made meaningful, interesting and relevant to the child, they are merely a series of pedagogical platitudes, for this is what every teacher must try to do. However, we do not think that this was the intention. If, on the other hand, the intention is to assert that the subject matter should be interesting, meaningful, relevant, etc. to the child before he has the learning experience - i.e. before the material is presented - then we feel that this is a dangerous and even disastrous educational doctrine.

An essential and major task of the project should be to ensure that the pupils acquire certain knowledge - concepts, principles, "facts", etc. - for without such knowledge future learning of many kinds is not possible. (Many items may be common to all or some pupils; many others may not.) If this is true, a great proportion of what they must learn will not and cannot in any meaningful sense be interesting, meaningful, relevant, etc. to them before the material is presented. It cannot be "meaningful", because if so there would be no need for them to have to learn to understand it. It often cannot be interesting, because they will not understand it, or even, in many cases, be aware of it. There may be many reasons for presenting some material which, in some sense or other, is "within the child's expereience", but there are overwhelming reasons for presenting a large proportion which is not. If by "relevant" content is meant that it is the teacher or materials developer who thinks the content is in some sense or other relevant, or that the child should learn to see it as relevant to himself, then this again is a platitude. If, however, the meaning is that the child should see the experience as relevant before he has it, then this could only mean either that the child is being given a form of practice, or that there is nothing which he needs to learn that he has not learnt already.

Although we believe that these are not the intentions of the people who have written these statements, we wish to point out that they have been traditionally used to support a particular position and that they have in fact promoted the development of certain types of curricula. They have been used to justify the position that the pupils concerned do not have to acquire any knowledge which they do not already possess, and this indeed is the logical implication of the statements. They therefore have often been used to support the position that because many pupils are incapable of acquiring the knowledge which, ideally, we would like them to acquire, then we shall decide either that they do not have to learn anything or else "dilute" the material to their level of ability - i.e. match their goals to their initial abilities. In either case there will be a strong emphasis on providing "interesting" and "enjoyable" activities which are already within the capacity of the pupils and material which is already within their experience. Curricula of this kind have in the past also tended to include a strong emphasis on what the pupils do - i.e., on activities or processes.

In order to show that these remarks are not based merely on imagination, we refer to a generation or more of social studies curricula which most people working in that field would now regard as educationally disastrous and based on an undesirable social philosphy.

The teacher and developer of materials must together decide what knowledge the child should acquire. This is his responsibility. It is logically impossible for the child to select it because he is literally unaware of the body of knowledge from which the selection must be made.

The selection of what the child should learn should be determined by many factors, of which the set of logical inter-relationships between the concepts, principles, etc. is only one. Whether the material is interesting,

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relevant, etc. to the child before has has the learning experience should not be one of these factors. On the contrary, most of the knowledge to be acquired is selected simply because it is not yet meaningful to the child, not seen as relevant by him, not within his past range of experience. (Incidentally, the notion of providing the child with experiences missing from, and often alien to, the culture in which he has been reared is central to the concept of compensatory education - indeed, we believe, to any morally acceptable philosophy of education.)

## III.

The knowledge to be selected for learning (which is not of course equivalent to the content to be studied or met with during the learning experiences) must, above a fairly simple level, be selected from the bodies of knowledge contained in the existing scientific disciplines. The reason why it must come from this source is that this is where it is - this is the knowledge we wish to communicate. This does not mean that the disciplines must be taught separately or that we should present courses sequenced according to the logical structure of the disciplines, although this structure will inevitably represent one important consideration in determining any educational sequence.

As far as sequence is concerned, we shall only add that if no knowledge has to be acquired, sequence in this respect is irrelevant. If some knowledge has to be acquired, sequence is obviously crucial. However, this argument applies also to skills, attitudes and anything else.

D.M. Bennett
M.L. Turner

## OBJECTIVES OF THE WEB OF LIFE - (AUSTRALIAN VERSION OF BSCS).

The broad aims of this course are to lead students:

1. To view biology (science) as a process of enquiry into the material world.

2. To become familiar with the procedures and ways of thinking of the research scientist.

3. To have some understanding of the living world as so far revealed by scientific investigation.

4. To be able to interpret data, formulate hypotheses, test hypotheses, and develop broad generalizations.

5. To be able to use the concepts and methods developed in the course in new areas of study and everyday situations.

6. To be able to think critically; to require evidence, be able to weigh evidence, and assess the reliability of inferences drawn from it.

7. To realize that hypotheses can be held with varying degrees of confidence and that, because of the very nature of science, our understanding of the world is continually changing.

8. To make judgements which also take into account the understandings and methods of science.

9. To be able to communicate ideas to others, both orally and in writing.

10. To develop practical skills in the handling of scientific apparatus and in recording observations.

In addition it is hoped that some of the students' attitudes and ways of thinking will change as a result of their experiences and activities during the course. In particular it is hoped that they will develop some appreciation of the diversity of living things and of the extent of their inter-relationship with each other and with their environments; and that they will learn to think of man as part of the living world and recognize that biology has a bearing on some human problems.

Bruce Johnson.

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## THE AIMS OF SELECTION OF SCIENCE CONTENT FOR GRADES 7-10

- Maclay

1. To create an awareness that science contributes to the value of all human experience rather than to its division into two "cultures" or more.

2. To involve pupils in activities which will

   a) reveal explanations of some of nature's relevant phenomena,

   b) provide methods of further exploration,

   c) create a lasting interest in seeking further understanding.

3. To provide opportunities for the acquisition of useful knowledge to allow understanding of

   a) the unity of science,

   b) the role of experiment, measurement and prediction,

   c) the contribution of technology,

   d) the responsibility of scientifically-informed citizenship.

## GUIDELINES FOR CHOICE OF CONTENT OF INTEGRATED SCIENCE

1. (For want of a better name) the Bernal aspects common to the sciences (convergence, information, singular properties and processes, nucleation, hierarchy, history, evolution).

2. The "big ideas" (energy, health, conservation, weather, interdependence, adaptation, ecology, variety, waves, gravitation, etc.)

3. The physico-chemical contribution (the structure and properties of matter together with the nature and effect of change)

4. The physiological contribution (photosynthesis, respiration, transport, metabolism, perception, co-ordination, reproduction, etc.)

5. Traditional science sub-divisions and topics (e.g. machines, mixture separation, electrical circuits, radioactivity, air, water, soil, cycles, growth, diversity, chemical activity, faults, fossils, furnaces, fuels, isostasy, erosion, etc.)

We now use these process guides for critical selection of content, consistent also with our aims, so that the pupils can receive the opportunity of a deepening perspective of science as a whole by cyclic extension. The first task is to involve the pupil's experience from primary sources which necessarily go far beyond the school. The contribution of B.S. Bloom's longitudinal studies emphasises our neglect of the early years of rapidly accelerating potential development. The issues of value for later years involve both the structure and function (or process) of science which in time are both consistent with the interests, needs, knowledge, skills appropriate for general education and also appropriate for extension to later secondary and tertiary activities. This critical selection of content is, therefore, a most responsible task.)

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## THE CONTRIBUTION OF J.D. BERNAL

The Science of Science Foundation 1964 has started a continuing programme of promoting the understanding of science in relation to society, 25 years after the appearance of Bernal's most significant book "The Social Function of Science". Bernal is one of the greatest physical chemists and has by this right just that interpretation of science perspective of value to our problem in its totality of aims. Elsewhere he has written as follows: - "We cannot isolate the physical sciences, and less so than at any previous time, from the general social and economic development that is going on around them. We have to take into account the urges that lead to certain branches of science being pushed forward while others are left relatively neglected." He extracts certain aspects common to the sciences as follows:

- the convergence of the physical sciences;
- the importance of the theory of language and information;
- the exploitation of specific, singular properties of certain forms of matter and of systems;
- the importance of the process of nucleation;
- the spread of the concept of hierarchy and order from the biological to the physical world;
- the introduction of the concept of history and evolution.

These common aspects enable us to select experiences relevant to all the traditional sciences. Of convergence he writes: "Science is becoming more like a vast net than like a tree and this has never been more evident that it is today when this closely meshed net reaches far beyond the physical sciences, through the biological sciences to the psychological and social sciences." "It is only now we are seeing that in the universe itself thereis a coherent pattern -. - The whole structure of the universe from the megagalaxy down to the fundamental particles inside the nucleons is now mapped in principle."

The fundamental electrical nature of matter is implicit in understanding science as unity.

Under information theory, he traces the development of communications from the telegraph to cybernetics, with also the senses, the intellect and the activities as human functions equivalent in machine terms to the input, computer and its memory and the output. The communication process continues as a daily challenge for the teacher in his relationship with the pupil, beyond the traditional chalk and talk. Bernal continues. " - we have made a working model of an organism, or to a lesser extent of a society, and this working model can, beyond its immediate utility, teach us on the one hand about the organism or the society of which it is a model, a on the other hand, about how to construct more and more effective and capable machines." "But the main point I want to make here is that the people who are making and using these machines are learning to think in a different way."

This all stresses the fundamental nature of communication and information as unifying themes in science. Such is the aim of reproduction.

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Under *singular properties* may be found such topics as magnetism, phosphors, transistors, ferrites, perfect crystals, to which we might add the properties used as *standards* and *singular processes*, e.g. fixed points, atomic weight, hardness, spectra, catalysis, ionisation energy, indicators, quanta, resonance, metamorphosis, stratigraphical succession, etc.

Under *nucleation* we find detonation, photography, geiger and other particle counters, crystallisation, image intensification. Under *hierarchies*, we may exploit any set of useful relationships as well as hierarchies of order. He continues: "The study of patterns over the whole field of science, both biological as well as physical, indicates that they are not assembled in a random way. Even an atomic nucleus, let alone a man, is not a fortuitous assembly of particles. But what is the principle of assembly? ---- the number of steps here are only a dozen between the largest arrangement of the galaxies that we know and the fundamental particles. It is also evident that the number of those steps, the position in a hierarchy of order, is what is more significant than the mere size. The simplest cell, for instance, has more hierarchy of order in it than the largest star." Much earlier, R.W. Gerard had emphasised also that we must not conclude that amoeba is less complex than a specialised animal cell. And so on to *history* and *evolution* which are more familiar in their potential contribution to integration.

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## RECOMMENDATIONS REGARDING THE ROLE OF THE STATES IN THE PROJECT

1. Continuous exchange of all information pertaining to developments in relevant areas of science education should be maintained between ASEP and State Advisory Committees and curriculum bodies.

   In particular, the outline plan for the development of materials by the Project should be made known to the States as soon as possible to enable syllabus committees to take Project developments into account.

2. State courses of study should not impose constraints on the Project's overall aims and objectives.

3. The entire program of ASEP materials should be planned and developed as an entity.

   The existence of JSSP materials should impose no constraint on the Project.

4. To allow for different entry points into secondary school in terms of age and primary science background and for variations in time allotment to science in junior secondary grades, it is important that materials for these students should show maximum flexibility, and be not too-closely identified with any particular grade.

5. It is anticipated that the aim of ASEP will best be achieved by materials originating within the Project but existing curriculum materials should be carefully scrutinized, used as a source of information and ideas and where appropriate, adapted or used to supplement ASEP materials.

6. There should be a free interchange of ideas and interaction between ASEP and other bodies or individuals engaged in related endeavours.

   From the beginning ASEP should encourage teachers to report ideas and experiences and submit materials for development by or in collaboration with the Project.

7. ASEP should give due consideration to the importance of public relations both within the teaching profession and in the general community.

   Advantage should be taken of opportunities provided by interstate conferences e.g. CONASTA, ANZAAS and professional journals e.g. Australian Science Teachers' Journal.

8. ASEP should bring to the notice of the Commonwealth and State Governments that the successful outcome of the Project will depend on the education of teachers in the use of the published materials and on the availability of the materials in schools.

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# OUTCOMES OF THE ASEP GUIDELINES CONFERENCE

The following statements represent a consensus of the opinions of Conference members on various aspects of the Project. These statements were arrived at in plenary session, and are reproduced with only minor amendments in phraseology.

## AIMS

The major aim of ASEP is to design science experiences, which contribute to the personal and social development of the child.

In particular, the Project should aim to develop:

* a balance between independence and interdependence in problem solving situations

* a commitment to enquiry as one mode of operation in life situations

* a willingness to adapt, to be flexible in new situations

* a concern with the social consequences of science and technology

* the child's creativity, and

* an understanding of man's physical and biological environment.

The following guidelines for the achievement of these aims are suggested.

1. The materials must cater for individual differences among students.

2. The students' immediate environment and interest should be important considerations guiding the types of materials selected and the methodology employed. For some learning experiences the immediate interests and familiar environment of the students are appropriate starting points for certain topics.

   For other learning experiences the materials should stem from the creation of a novel and relevant environment and the stimulation of new interests in the students.

3. The Project should be concerned with helping students to take their place in society and preparing them to make a responsible contribution to the society in which they will be adults.

4. Science can be described as both a structured and evolving body of knowledge and an array of skills by which information is generated, interpreted, and applied. Some coherence is necessary in the selection and development of science experiences. Yet no one organizational thread need predominate.

   Among the possibilities are

   (a) modes of enquiry e.g. use of a control in experiments
   (b) themes e.g. population control
   (c) conceptual schemes e.g. particulate nature of matter
   (d) overriding concepts e.g. dynamic equilibrium
   (e) historical approach to a topic e.g. electricity.

   All these are important but the balance among them and their relationship to the other major considerations of personal and social development and relevance to the students'

AIMS (contd.)

familiar environment may change from stage to stage and may be different for students of different ability.

5. The further studies of students using the materials of the Project will to some extent be dependent on them and grow out of them - but should not dominate the design of the materials.

6. The materials should help pupils and teachers to initiate and develop their own enquiries, both individually and co-operatively.

MATERIALS

1. The Project should endeavour to ensure that all pupils, irrespective of their abilities at entry to the secondary school, are able to learn successfully. Therefore it is important that, as far as possible, allowance be made for individual differences. Differences that should be taken into account include those in reading ability, in ability to communicate both orally and in writing, in level of maturation, in development towards abstract thought, in interests and attitudes, and in motor skills.

2. The Project should recognize that pupils differ greatly in their range of past experiences and that therefore many different kinds of learning experiences should be provided. Attention should be paid to the results of poor home and school background.

3. The design of the Project materials should be such as to accommodate differences in school organization - for example, heterogeneous grouping and forms of streaming and tracking.

4. The Project should recognize the vital importance of the teacher and of his role in fostering maximum interaction between the child and the materials provided.

5. The materials should provide a maximum of support to those teachers who require or seek it while allowing as much freedom as possible for those who desire it. The recommended roles and tasks of the teacher in each part of the work should be clearly delineated.

6. The Conference approves in general the recommendations presented concerning the development of materials. In particular the developmental sequence (Stages 1, 2, 3) based on Piaget's concrete and formal stages is considered preferable to one based on grade levels. It should be a major feature of the rationale that the materials assist the pupils to make the transition between these stages.

7. An inquiry approach should predominate, the materials being so constructed that inquiry situations result in pupil activity, both individual and group.

8. The learning materials prepared by the Project should have a sound theoretical basis and relevant literature in the fields of psychology, sociology, and education should be adequately examined by the Project.

## SERVICES

1. While recognizing that the nature of the materials themselves will determine the actual weighting given to teacher education, evaluation, and other services, it is recommended that these areas be not underestimated. It is expected that a large part of the $1.2 million budget for the Project will be used on these services, yet other resources outside the Project do exist (e.g. in-service education programs of State Education Departments). These other resources should be investigated for possible contributions to the Project in the initial planning stages.

2. A general outline of evaluation needs should be produced for information and for critical constructive comment. External evaluation of the Project should be encouraged, and linked where possible with the interests/needs of the Project.

3. Some of the evaluation instruments and procedures the Project will require do not exist at present. These should be produced as a result of Project activities and part of this will need to be done outside the Project.

4. The service aspects of the Project are seen as having both a short-term and a long-term function. The short-term service function should be seen as an intrinsic part of the development of the Project. The long-term function, for example, the setting up of more permanent resource centres, should be kept in mind by the Project.

5. The Conference approves in general the recommendations presented on the service aspects of the Project. In particular, the suggestions for conducting trials of Project materials and the principle of localized trials in various parts of Australia are endorsed. It suggests that the function of such trials is greater than to provide feedback on materials as it involves aspects such as teacher-education and State involvement.

## ROLE OF THE STATES

1. Continuous exchange of relevant information should be maintained between ASEP and State Advisory Committees and other curriculum bodies. In particular, the outline plan for the development of materials by the Project should be made known to the States as soon as possible to enable syllabus committees to take Project developments into account.

2. State courses of study should not impose constraints on the Project's overall aims and objectives.

3. The entire program of ASEP materials should be planned and developed as an entity. The existence of JSSP materials should impose no constraint on the Project.

4. To allow for different entry points into secondary school in terms of age and primary science background and for variations in time allotment to science in junior secondary grades, it is important that materials for these students show maximum flexibility, and should not be too closely identified with any particular grade.

5. It is anticipated that the aims of ASEP will usually be best achieved by materials originating within the Project; but existing curriculum materials should be carefully scrutinized, used as a source of information and ideas and where appropriate, and adapted or used to supplement ASEP materials.

ROLE OF THE STATES (contd.)

6. There should be a free interchange of ideas and interaction between ASEP and other bodies or individuals engaged in related endeavours. From the beginning ASEP should encourage teachers to report ideas and experiences and submit materials for development by or in collaboration with the Project. ASEP should also explore ways of involving teachers in the development of the materials.

7. ASEP should give due consideration to the importance of public relations both within the teaching profession and in the general community. Advantage should be taken of opportunities provided by interstate conferences e.g. CONASTA, ANZAAS and professional journals e.g. Australian Science Teachers' Journal.

8. ASEP should bring to the notice of the Commonwealth and State Governments that the successful outcome of the Project will depend on the education of teachers in the use of the published materials and on the availability of the materials in schools.

## Aims

The aim of the Australian Science Education Project is to design science experiences, which contribute to the personal and social development of the child.

In particular, the Project will aim to develop a balance between independence and inter-dependence, in problem solving situations, a commitment to enquiry, a willingness to adapt, to be flexible in new situations, a concern with the social consequences of science and technology, the child's creativity, and an understanding of man's physical and biological environment.

The Conference has produced a series of guidelines for the achievement of these aims.

## Materials

The materials to be produced by the Project will assist teachers to help children to learn science effectively. The materials will provide for differences that exist in children, teachers and school environments. An inquiry approach based on a variety of active student investigation will be adopted. The learning procedures incorporated will have a sound theoretical basis and will take into account modern theories of child development.

## Evaluation

The education of teachers to use the materials has high priority, and the involvement of teachers and teacher education institutions is vital to the success of the Project. The materials will be critically reviewed by scientists, science educators, and social scientists to ensure validity. Trials of the materials will be conducted in all States to ensure that they meet the needs of children throughout Australia. As a result of the evaluation program planned for all aspects of the Project, information will be obtained for future curriculum development.

## Role of the States

The Australian Science Education Project is a unique cooperative venture involving governments and educational organizations of both Commonwealth and States. The envisaged continuing interchange of information and ideas on the development of a wide variety of materials between the Project and all involved in Secondary Science Education may provide a significant pattern for future progress in Australian education.

# ASEP GUIDELINES CONFERENCE

## SUMMING UP - MR M.BISHOP

My task this afternoon is not an easy one. Headmasters are seen as a rule as a sorry lot, more to be pitied than derided, more certain to be criticised than to be praised and certain to be misunderstood and regarded as having little or no experience to fit them for their role. I am grateful therefore for the invitation to join this Guidelines Conference even if my tribute money must take the form of this thank offering.

As I perceive it, my task is, by 'thumming up the themes', to prevent the fabric of the Conference from coming apart at its seams. I hope to be light fingered enough to pull some strands together and to substitute or remove others without treading on too many toes.

There is no doubt that we have worked hard - and none harder than Mr Director Howard and his Project Staff. There is no doubt that we have all had sufficient experience of educational conferences to realise the danger imminent in all of them of taking ourselves and our subjects too seriously. I commend to you the behaviour of certain subsidiary syndicate leaders for encouraging sufficiently divergent compensatory behaviours to allow us to recover a healthy interest in the purple curtain of the night and its rosé fingered dawn (for those who know their Homer) or for those who prefer Stilton (I'm sorry Milton) - did all in their power to see that Loathed melancholy of darkest Cerberus born Was chased hence.

Robert Wilkinson's camera though small has not been unnoticed and I would seriously commend to you a rubric for the group photograph. In the Centre top in letters of gold should be printed

A.S.E.P.T.I.C. ANTICS
(taken in confidence)

MONASH JANUARY 1970

in the lower left corner the letters

A.P.P.S. (A pristine purity shot)

and in the lower right the letters

FEN.007

We are I see (hear) beginning to communicate with one another, and so to the problems of communication associated with the Project I will direct my first observation.

The Project has a significant and important problem to solve before it will be able to successfully communicate its value, its significance and its importance to, as Mr Ford listed them .... Governments, Teachers, Parents and the Community. We have recognised this in part. The Director spoke of living in a wind tunnel - Mr Wilkinson asked for explanations of Curriculum, Syllabus and Course - I suspect others of us were too shy to ask.

If I were to sum up the proceedings of the conference by saying:- "The outcomes of the competencies of our four syndicates arising especially from their appraisals of the merits of the sequential, hierarchical and open ended materials proposed as environmental applications for the extensions of knowledge in the classroom situation and intended to provide for signal learning on the main track guide lines having their origins in the positions of Gagne, McLeish, Bloom and Krathwohl and extending to those of French Havinghurst and Guildford, will ensure in summary the formative, summative, cognitive and affective evaluations sought for a Piaget type curriculum by the all respective self directed, self evaluative members of the State Advisory Committees". You would have to agree that I have been listening - that I have learnt the words but somehow have missed the woods for the trees. I don't think what I wrote means anything - should I read it again?

Certainly we ought not to waste time on semantics as so many told us but equally we must take care to be understood and unambiguously, so or we will be described in terms such as:-

See the little phrases go
Watch their funny antics
The men who make them wiggle so
Are teachers or semantics.

---

The words go up - the words go round
And make a great commotion
But all that lies behind the sound
Is Hebetude Bœotian.

We do have as our American cousins say, a linguistics communications problem of a very real kind for if we have been confused or just a little uncertain, how much more so will be our less interested colleagues and the laymen (and women) in the community.

I can visualise a restless science teacher wrestling before falling to sleep with the names of the Educational reports and Science Curriculum Projects from which ASEP will be derived.

Oft in the stilly night
When the mind is fumbling fuzzily
I brood about how little I know
And know that little so muzzily
E're slumbers chains have bound me
I think it would suit me nicely
If I knew one tenth of the little I know
But knew that tenth precisely

O - IPS, BSCS,
And what's its name - QPS
O Martin, O Watkin
O Dettman, O Wyndham
I know that each will claim its fame
I'm sure they stand for something
But recalling what it is I'm not.

O Dainton, O Jackson
O Ramsey, Wark and Hughes
How can I choose? Of course there's Nuffield.

And three A's S and three S - P's
And double S PC's and double S JPS
My mind is letter wracked and ill at ease
Gently my eyelids close
I'd rather be good than clever
I'd rather have my facts all wrong
Than have no facts whatever.

Observation number one then is:- Communicate or perish.

Observation number two is:- Know your client - for just as a wise child knows its father .... hence the origin of the clever little bastard - so too, I believe, a communicating Project is wise to know its client.

As a Headmaster, as a parent, as a taxpayer, as a teacher may I suggest, with all the humility associated with Headmasters at the very least - the child (pupil) is not the Project's client - rather is he (she) to use one of the dehumanising, engineering analogies we seem to use so easily, the raw material of the educative process. It is our business as educators to design experiences for him and to compulsorily expose him to them. Parents are clients of the Project for they are as a rule unequal to the task of educating their children and being so, delegate their responsibility to schools. We ought to recognise this and in accepting the responsibility exercise it wisely, being careful not to become like

The old woman with notions quite new
She never told children what they should do
But hoisted the covers right over her head
When people explained where her theories led.

We know what we mean, or do we, when we talk of a child centred curriculum and we have done well to guard against the dangers of letting the child choose.

There is nothing like instinct - fortunately.

I suppose the plumbers' children know more about plumbing than plumbers do, and welders' children more about welding than welders.

Because the only fact in an implausible world is that all young know better than their elders.

A young person is a person with nothing to learn, one who already knows that ice does not chill and fire does not burn.

It knows it can read indefinitely in the dark and do its eyes no harm.

It knows it can spend six hours in the sun on its first day at the beach without ending up a skinless beet. And it knows it can walk barefoot through the barn without running a nail in its feet.

It knows it doesn't need a raincoat if it's raining or galoshes if it's snowing. And knows how to manage a boat without ever having done any sailing or rowing.

It knows after every sporting contest that it had really picked the winner. And that its appetite is not affected by eating three chocolate bars covered with peanut butter and guava jelly, fifteen minutes before dinner.

Most of all it knows that only other people catch colds through sitting around in draughts in wet clothes.

Meanwhile psychologists (Project writers) grow rich writing that the young are ones parents should not undermine the confidence of which.

I suspect as many of you do and Dr Vickery does - curricula for life, but in suspecting let us not forget that though our society no longer expects our school leavers to become hewers of wood and drawers of water it and our Governments will be very worried about their investment if they leave school as hewers of water and drawers of wood.

Observation number three

It is vital I agree that the Project provide for differences in ability and for movement from one kind of material to another.

I have been moved by the concern for the disadvantaged and for the under-privileged child shown by more than one speaker.

I am perturbed that much less concern has been shown for the disadvantaged or underprivileged teacher.

Most of all however am I concerned that ASEP will discover too late what every member of the oldest profession in the world knows .... It cannot be all things to all men. As we have talked about these matters touching on individual differences I have seen a danger that ASEP will/may prostitute its resources.

I suggest to you that underprivileged children exist in all our schools - even at Cranbrook - and the correction, compensation for this lack of privilege is both costly and time consuming which makes its correction more costly.

The physically hungry child in the slums is less underprivileged and disadvantaged than the emotionally hungry - the unloved in the homes of the wealthy whose two or four or six "parents" see the trappings of our culture as substituting for their affection - "You have your bike - your transistor - your portable T.V. ..... What more do you want?"

The underprivileged illiterate has his counterpart in the underprivileged frustrated foreign language speaking immigrant rich and poor. And just as George Bernard Shaw suggests in his preface to Major Barbara it is impossible to convert a man on an empty stomach. So too would I suggest it is not really possible for ASEP to introduce to science the underprivileged without a very expensive supportive program of assistance. The stopped tongue and the closed ear and eye of underprivilege have their origins in many wells of darkness. The cost of unstopping and opening will be huge. It cost $165 to teach a non-English speaking 14 year old Czech boy, English, at Cranbrook last term - we charge $200 a term for day boy fees and the State estimates that it costs $300 per pupil per annum to educate a secondary pupil.

Relief for that boy depended on two things happening - a sympathetic teacher and a school which recognised the problem. Money existed to pay for his 12 week Laboratory Course - it came out of his school fees.

I have mentioned earlier the underprivileged teacher. I see a very real need for the Project to concern itself with his relief for he will affect hundreds of children adversely day after day unless he becomes a better teacher.

The disadvantaged teacher is at his worst not out of date or in an ill equipped school. He may be. But he is more often characterised by never having seen himself as co-operating with his pupils, their parents and his colleagues but rather as dominating, controlling, directing and at worst I suggest as manipulating them. He is unaware of Bubers I-thou relationships and possesses only I-them, I-it conceptions of his role. Such teachers are more numerous than we usually admit, and have small spirits. The problem for ASEP is not only to put good materials into their hands but to try to enlarge their spirit as well. How can we persuade such teachers in Herbert's words that -

The man who looks on glass

On it may stay his eye

Or through it pass

And the Heavens espy.

How can we convey to them what is conveyed by the symbolism of a baby's hand in its mother's, which is used by the training college of which Madame deVits was head in Belgium or the figures of a pupil and teacher holding hand on the A.I.D.A. medal?

Sir Eric James (Lord James of Rushholme) was reported in 1962 as saying "The whole problem of science education is beset by two major difficulties. The first we will surmount in time. It is simply ignorance of what we should be trying to do and how to accomplish it. We shall go on pegging away and sharing our knowledge as teachers have learned to do. The second difficulty will be harder to overcome. The most important limiting factor in this as in all kinds of education, is the quality of the individual teacher."

It is right that ASEP should be concerning itself with providing experiences for pupils in our schools which will allow them to grow and fit them for their places in the 21st Century - that is challenging enough. But what Dr Radford and others have not reminded us is that many of the teachers who will use ASEP materials in the near future will still be teaching in the 21st Century.

If I may quote Lord James of Rushholme again - this time from the conclusion of his Wallace Worth Memorial Lecture (31.10.67) "We need more and better teachers. The only solution I can really offer is as difficult to achieve as it is easy to state. We delude ourselves if we think that new techniques can ever be more than aids - necessary, valuable, but still aids. We delude ourselves if we believe that unlimited research in education will provide a series of simple answers for education in the new world, though some such research is necessary. But in the last resort, if our education is to get better, as it must, it will get better because it is carried on by more educated, more sensitive, and more human people who are not afraid to emphasise the social and moral relevance of what they teach. Universities can help to provide them by encouraging some of the best people to go into the profession of teaching; the State can help not only by the financial priority it gives education but by basing its estimate of the outstanding teacher on his personal qualifications and his own education rather than on the jejune criteria of specialised competence in certain techniques; Society as a whole can help by its attitude to the teacher, and I mean the teacher, and not only the administrator or the educationist. The teacher bears the greatest responsibility of all because he has to realise clearly that the career he has chosen demands from him in the modern world a continuing effort of self education.

And it is only by such effort that he can hope to discharge his multiple obligations, as one who transmits knowledge, who stands for certain values and who encourages at any rate some of his pupils to that constructive and ruthless questioning and those bold imaginative visions on which material and cultural progress alike depend."

Observation number four

I believe this also is a major one and as serious for ASEP as the problems of more and better teachers.

It has been an exciting week - taking part in the establishment of guidelines for the development and growth of the Project. For the first time in Australia the scientific method, of which Bacon spoke and about which scientists have known for a long time, has been recognised by the Government and will in time be by our people as the best way to generate more and better achievements and transformations in the teaching of science.

As you/we have discussed the possible aims, purposes, objectives and materials for the Project I became increasingly disconcerted. It seemed that ASEP was becoming more and more like a scientist bachelor who, wishing to marry set about the task of finding his future wife by proceeding in the way we have done to formulate his proposal.

The Project he wished to undertake and for which he obviously felt sufficiently funded was clear enough but what were his aims? What were his purposes? What were his objectives? And what would be the expected outcomes of his stated aims, purposes, objectives and outcomes? What criteria should he use in setting up aims, purposes, objectives and outcomes? How would he evaluate the effectiveness of his Project?

Who of all the single girls should he approach first? Need they be single?

On what basis could he rank criteria such as blonde hair ahead of red hair, and sweet lips ahead of red lips and wealth ahead of brains? Should physical criteria loom larger than sociability factors?

And having chosen the object of his scientific passion what then? How could he court her without knowing her likely response to signals such as

May I press my suit

May I kiss you

Darling my hands are cold

and how should he evaluate responses such as

Of course - the iron's in the kitchen

Of course - you may kiss my foot

Of course - why not sit on them.

And how could he know the signals were unambiguously interpreted because there were reports of one suitor who while pressing his suit had been given a dollar and told he could get what he wanted at King's Cross - the laundrette.

He had heard too of American agencies who chose secretaries for business men using task performance criteria and evaluation programmes yet who often had their clear choice of a Miss Jones - typing speed 110 words per minute, shorthand 200 words per minute, single and 43, rejected in favour of a Miss Venus - typing speed 25 words per minute, longhand 10 words per minute, single, 22, who always wore a sweater to the office.

ASEP at present has much in common with our bachelor. Value judgments will have to be made - not all the data on which to base quite arbitrary decisions will be available now or in the future and information about other Projects will be both illuminating and confusing.

The members of this Conference are, on my observation, as well qualified by experience, interest and intelligence to accept the responsibility they are charged with - the recommending of guidelines to the Director and his executive staff. They are as well qualified too as any I know to report clearly and confidently back to their States and Teachers' Associations that the Project has begun well and promises in the next five years to make possible a significant improvement in the quality of science teaching in this country.

## AUSTRALIAN SCIENCE EDUCATION PROJECT
## GUIDELINES CONFERENCE - JANUARY 23, 1970

### CLOSING REMARKS - DR WM.C.RADFORD, DIRECTOR ACER

It seems a long time since Robert Wilkinson came to ACER in 1964 and asked if we could look after the preparation of educational materials to give substance to a new syllabus which the Universities and Schools Examinations Board here had blessed, after a lot of hard work by a Standing Committee and a small primary grant from the Myer Foundation. We expected then to have up to six people for a few years for a four year syllabus.

We finally had about that number, but only by the good graces of the Victorian Education Department, the sweating of blood and tears by Project staff in getting scant funds from industry and from foundations, and a quite considerable debit balance in ACER's account books on JSSP. But the near one score of units of materials available and the practical proof to Governments that this kind of full-time endeavour got different results, was important.

It seems a long time, and it has at times been frustratingly slow time since those of us who were then associated with JSSP took up the then Senator Gorton's promise, and ACER arranged a week long meeting in Melbourne in 1967 to thrash out the details of a possible submission from South Australia, Tasmania, Victoria and ACER to the Commonwealth, had that submission approved by Ministers, and got it to the Commonwealth early in 1968.

It has seemed a longer time still since the Commonwealth's part-acceptance of that proposal (part - because we had anticipated complete financing by the Commonwealth) in August 1968, and financial and other negotiations have appeared to drag with leaden feet at times.

Yet I think few of us would have dared to think, in 1965, that in early 1970 there would have been a Conference of this kind with its purposes so clear and the collaboration of all possible partners so definite and so cheering. Our time perspectives need to be long ones, and our patience well nigh inexhaustible, but historically important events do eventuate given good will, people able and willing to take advantage of events when their promise is seen, and optimism. This has been one of those events, and it owes much to many people, not all of whom are present. Organization is important, but intelligent collaboration is more important still. The Committee of Management and the Project staff, and ACER as the day to day manager can see this Conference as a real converter on the power line of a highly significant Project in national educational planning. It has set precedents and standards, but only because of the willing cooperation of men and women of good will. Thank you all.

I thought it might be worth leaving this poem with you, because I think it is relevant, I think as I said, to the children for whom this particular project is being operated.

Once I did not know the birds were described,
classified, observed, fixed in their proper localities.
Each bird that sprang from its tree, passed overhead, hawked
from the bough,
was sole, new, dressed as no other was dressed.
Any leaf might hide the paradise-bird.

Once I believed any poem might follow my pen,
any road might beckon my feet to mapless horizons
any eyes that I met, any hand that I took, any word
that I heard,
might pierce to my heart, stay forever in mind, open worlds
on its hinge.
All then seemed possible; time and world were my own.

Now I know that each star has its path, each bird
is finally feathered and grown in the unbroken shell,
each tree in the seed, each song in the life laid down -
is the night sky any less strange; should my glance less follow
the flight;
should the pen shake less in my hand?

No, more and more like a birth looks the scheduled rising
of Venus;
the burn of a wing in the wind more startles my blood.
Every path and life leads one way only,
out of continual miracle through creation's fable,
over and over repeated but never yet understood
as every word leads back to the blending original Word.

Judith Wright. To Hafiz of Shiraz

It has been the purpose of the Conference "Let there be Light" and I think it has been achieved.

B. Rechter

While accepting the fact that the result of the teaching and learning of the material produced in the Project will involve the accumulation of a body of science knowledge and process, the problem remains as to what should be the criterion for selecting the experiences to be presented to the students.

A science discipline is a highly structured body of concepts and principles with an elegant "line of development". It seems to me important to resist the temptation to use this structure as the major selection criterion, though this is not to deny the importance of this knowledge for the child.

An alternative approach is to recognize that science is not primarily a body of knowledge but a form of activity - a rational and ordered, deliberate way of changing the environment (for good or for ill).

In this situation it seems possible to leave the direct learning of science as a body of knowledge to at best the tertiary institutions or at least the senior school classes, and concentrate on the interforce of science and the environment (physical, biological, social psychological) as the source of units and "content" areas - allowing the structured pattern of the sciences to emerge only by "accident" as it were. Thus a unit on "The concept of acidity" is not warranted, whereas one on "Water - wet and hard" is.

What then happens to the problem of sequential skills? I think the problem of sequence and "essential" knowledge must not be overstressed at this level of education. We need a hard look at just what Science knowledge is most worth and how little sequence we can get away with.

The danger of "life-adjustment" courses is self-evident but perhaps the pendulum has swung too far and needs readjustment along such lines as suggested by the BSCS new guidelines for grades 7 to 10.

Best Avialable

## VIEW 1: EXPRESSED BY R. SHEPHERD ON THE AIMS

If ASEP merely produces materials to enable children to learn scientific knowledge, it will achieve nothing that hasn't been done for the past 20 years.

That there is a core of basic scientific ideas which students must learn may well be a relic of the assumption that science education at the junior secondary level is a preparation for later study in science.

Children live in an environment which has been transformed or created by the applications of science, and their "science education" could well consist of learning how some of these changes have come about, and developing an interest and concern towards the consequences of the scientific endeavour. In this process of doing this, the children will inevitably learn a great deal of scientific knowledge.

Ron Shepherd
21st January, 1970

Best Avialable

# SOME SUGGESTED AMENDMENTS TO THE "AIMS" BY N. WILSON

1.1 Science classroom experiences should contribute to the personal and social development of the child.

In particular, they should aim to develop

a balance between independence and independence in problem solving situations.

a committment to enquiry as one mode of operation in life situations

a willingness to adapt, to be flexible, in new situations.

1.2, 1.3 Accept

1.4 The disciplines that qualify as sciences are many and varied. Most sciences are still at the stage of empiric generalization. Some have not reached this stage. Some have gone beyond it. But it is felt that such second and third order descriptions of the environment, if they become major components of content for grades 7 and 10, will unnecessarily restrict the range of experiences of students. Further, it is felt that such theoretical formulations are of little concern, or use in the lives of ordinary citizens. So it is believed that modes of enquiry, not 'big ideas', should provide the secondary criterion for selection of content.

1.5 (delete)

1.6 Suggest last sentence read

"Cognizance must be taken of the needs of all students."

Best Avialable

# CRITERIA FOR SELECTION OF 'SOCIAL' AND PSYCHOLOGICAL' MATERIAL FOR 'SCIENCE' LEARNINGS

In general, I believe the raw material for social and psychological learnings should be the behaviours within the classroom itself, the interactions among students and teacher, and within and between class groups as they go about their tasks.

Such behaviours are an integral part of a living and learning situation. As such they are a part of the student's immediate environment and are amenable to objective investigation, discussion and modification. If learning is the ultimate aim of the classroom experience, it would seem reasonable that the learning process itself, together with inhbitive or facilitive conditions, should itself be a matter for scientific investigation. Techniques for the investigation of such planning are available (e.g. Encounter group techniques - National Training Laboratory), but many teachers would need special training before they would utilize the techniques. Such social behaviours would become a subject for investigation either when students themselves considered them matters of real concern, or when the teacher believed that valuable learnings would acrue from such discussion.

A further justification for such investigation is this - that if science is concerned as a method of enquiry that should be incorporated by students as a permanent mode of behaviour, then there is a certain dishonesty in limiting such behaviours to investigation of physical and biological phenomenon; for in life, most people have far more opportunites for scientific behaviour in personal interactive situations, than in more abstract physical and biological areas.

In addition to the above, of course, units relating to such matters as effects of drugs, have a valuable place in a science programme. Such matters would not normally occur directly as classroom fa data, but they are matters where personal decisions of great importance, having a basis in scientific knowledge, will be made by many students.

Noel Wilson

Best Avialable

# "WHAT ARE THE CRITERIA FOR SELECTION OF THE SCIENCE-LINKED EXPERIENCES THAT SHOULD CONSTITUTE THE SUBJECT MATTER OF THE MATERIALS?"

1. ASSUMPTION:

The materials to be produced will be in 'units', 'blocks', 'modules' or what have you.

2. AIMS:

The aims of ASEP may be classed as follows:

2.1 Extension of the pupil's horizons as they relate to the external world of space and time, and of man's place in all this.
i.e. the "structured and dynamic body of knowledge", from which the JSSP has selected as illustrating:

the external world - (astronomy & geology)
how the constituents of the external world
interact - (physics)
the special case of the interactions between atoms
& molecules - (chemistry)
the biological world and man's place in it,
(biology);
and man's interaction with his physical &
biological environment.

2.2 Aims associated with the methods, processes, tools etc., whereby acientists acquire this knowledge, and exploit that knowledge.

Aims associated with the history of science and man's developing awareness of his environment.

Aims associated with personal attitudes - integrity, suspension of judgement etc.

Aims associated with the development of some motor skills and communication skills.

2.3 Development of attitudes:
between man and man
between man and his environment

3. JUSTIFICATION OF THESE AIMS:

3.1 Aims 2.1 can be justified on the grounds of:

3.1.1 survival - of the individual and of the race;
3.1.2 desired type of society to live in;
3.1.3 interest.

3.2 Aims 2.2. can be justified on the grounds that they contribure to the first aim, 2.1; and also on other grounds, that they are good things in themselves - presumably because certain attitudes etc. may be more conductive to individual and social survival than others.

3.3 Aim 2.3 can be justified on the grounds that they lead to survival in the long term.

Note that in dealing with attitudes between man and man, and man and his environment, it would be proper to assert that an adequate knowledge of man and environment is a pre-requisite to rational decisions.

Best Avialable

## 4. THE UNIQUE CONTRIBUTION OF SCIENCE:

4.1 Aim 2.1 can only be achieved by science experiences.

4.2 Aims 2.2 could also be achieved by other types of experiences.

4.3 Aim 2.3 must be based on science experiences if it is to have a rational basis and not be mere authority.

## 5. CONSEQUENCES:

5.1 A course that does not achieve Aim 2.1 could not be called science, because that is what science IS.

This is not to say that such experiences would have no value, but that they cannot be called science.

5.2 If you have a "Science" Curriculum, then the science must be such as to hold the respect of scientists.

If the "science" is not good, or is not science, then it will not hold this respect, and the consequence of this would be tragic.

## 6. METHODS TO ACHIEVE THIS:

6.1 Criteria for selection of "science-linked" experiences .....

6.2 Who decides the criteria, and what are the criteria upon which they base the criteria?

## 7. THE JSSP APPROACH:

| | |
|---|---|
| 7.1 "Scientists" | - to state what is the science in the various areas at the present time;<br>- no consideration at this stage as to whether this could be taught in schools, or whether it should be taught;<br>- indicate that portions they consider to be "essential", and what concepts etc. are vital. |
| "Educationalists" | - to state what are the methods of learning etc. at are likely to be fruitful, and to state methods of assessment and evaluation that are likely to be successful. |
| "Practising Teachers" | - to state in the light of their past and pilot experience, what is likely to be successful with pupils;<br>- to set out the "tactics and techniques" the "logistics of the classroom" which will be needed. |

7.2 These groups are not mutually exclusive; and each group is a "necessary" but not "sufficient" conditions for fruitful endavour.

7.3 The practical priorities seem to be for the Scientists, (aided and abetted by the others at times), to set out some items relevant in the areas considered.

The Scientists then meet together and see what links between their various areas can be traced; and what pre-requisites they are assuming.

Best Avialable

7.3 (Contd.)

This leads on to the suggestion of "proto-units" ...

The "proto-unit" is seen to require certain skills etc., certain pre-requisites and so forth, certain processes in order to reach the goals set out; and these must be brought in either prior to, or concurrently with, the development of the unit:

Certain proto-units may be seen to be excellent vehicles for particular processes - e.g. "instrumentation"; and others for the development of particular attitudes, and conscious effort should be made to cover all the aims of 2.2 ... 2.5 in some part or other of the whole curriculum.

Based on all this, the first development of a particular "unit" can be commenced.

7.4 The writer would hope, that as a result of these procedures, a fairly well structured curriculum could be drawn up from the units preface. This implies of course, that such structure should be aimed at in the selection of the proto-units; but it does not mean that any lock-step sequences should be built in. Some minimum 'core' should be developed, and various options to make provision for local requirements and teacher strengths. The writer would deplore the development of haphazard collections of isolated "science experiences".

7.5 Addendum to JSSP approach:

It may also be a fruitful endeavour in some cases to consider a certain attitude goal - such as "pollution", and to think out what this would imply in the way of pre-requisites, and to ensue that these are incorporated somewhere. But obviously, such units might be easier to bring in later in the course, when background is more adequate.

## 8. CONCLUSIONS:

The JSSP type of approach is likely to be more fruitful in achieving Aim 2.1 than any decisions a priori of "criteria for selection".

Any philosophy, development of attitudes, etc. based on inadequate knowledge of, or in defiance of, the external universe and of man's place in it, is likely to be dangerously deficient.

R.H. WILKINSON
21/1/1970.

Best Avialable

## FRIDAY JANUARY 23

Review of the Conference

morning : special syndicate sessions to review the four main areas : AIMS, MATERIALS, SERVICES, THE ROLE OF THE STATES

afternoon : plenary session to consider, amend where necessary and accept special syndicate reports

: summing up by Mr M. Bishop
: final remarks by Dr Wm. C. Radford

## THE AIM OF THE AUSTRALIAN SCIENCE EDUCATION PROJECT

The aims of ASEP is to design science experiences, which contribute to the personal and social development of the child.

In particular, the Project should aim to develop:

* a balance between independence and interdependence in problem solving situations

* a commitment to enquiry as one mode of operation in life situations

* a willingness to adapt, to be flexible in new situations

* a concern with the social consequences of science and technology

* the child's creativity, and

* an understanding of man's physical and biological environment.

**The following guidelines to the achievement of these aims are presented:**

1. The materials must cater for individual differences between students.

2. The pupil's immediate environment and interest should be one important determinant guiding the types of materials selected and the methodology employed. For some students, their familiar environment and immediate interests are appropriate starting points for certain topics.

   For some students and/or for some topics the materials should stem from the creation of a novel and relevant environment and the stimulation of new interests.

3. The programme should be concerned with helping students to take their place in society and preparing them to make a responsible contribution to the society in which they will be adults.

4. Science can be described as both a structured and evolving body of knowledge and an array of skills by which information is generated, interpreted and applied.

   Some coherence is necessary in the selection and, development of science experiences.

   No one organizational thread need predominate.

   Among the possibilities are

   (a) modes of enquiry e.g. use of a control in experiments

   (b) themes e.g. birth control

   (c) conceptual schemes e.g. particulate nature of matter

   (d) overriding concepts e.g. dynamic equilibrium

   (e) historical approach to a topic e.g. electricity.

   All these are important but the balance among them and their relationship to the other major considerations of personal and social development and relevance to the students' familiar environment may change from stage to stage and may be different for students of different ability.

5. The further studies of students using the materials of the project will to some extent be dependent on them and grow out of them - but should not dominate the design of the materials.

6. The materials should help both pupils and teachers to initiate and develop their own enquiries, both individually and co-operatively.

Best Avialable

## MATERIALS

The Project should endeavour to ensure that all pupils, irrespective of their abilities at entry to the secondary school, are able to learn successfully. Therefore it is important that as far as possible allowance be made for individual differences. Differences that should be taken into account include those in reading ability, inability to communicate both orally and in writing, in level of maturation, in development towards abstract thought, in interests and attitudes, and in motor skills.

The Project should recognize that pupils differ greatly in their range of past experiences and that therefore many different kinds of learning experiences should be provided. Attention should be paid to the results of poor home and school background.

The design of the Project materials should be such as to accommodate differences in school organization - for example, heterogeneous grouping and forms of streaming and tracking.

We recognize the vital importance of the teacher whose role is to foster maximum interaction between the child and the materials provided.

The materials will provide a maximum of support to those teachers who require or seek it while allowing as much freedom as possible for creative and imaginative teachers. It is therefore recommended that the roles and tasks of the teacher in each part of the work be clearly delineated, the physical and other demands on teachers being decreased rather than increased.

The Conference approves in general the recommendations as set out in Appendix 2 of the paper presented by Mr. L.G. Dale.

In particular the developmental sequence (Stages 1, 2, 3) based on Piaget's concrete and formal stages is considered preferable to one based on grade levels.

It should be a major feature of the rationale that the materials assist the pupils to make the transition between these stages.

An enquiry approach should be used; the materials being so constructed that enquiry situations result in pupil activity both individual and group.

### Preferred Form

The learning materials prepared by the Project should have a sound theoretical basis and relevant literature in the fields of psychology, sociology and education should be adequately examined by the Project. Dr. Turner's paper is part of this literature.

Best Avialable

Syndicate Room 2

## EVALUATION

While recognizing that the nature of the materials themselves will determine the actual weighting given to teacher education, evaluation and other services, it is recommended that these areas be not underestimated. While it is expected that a large part of the resources of the Project could be used for these, it is also recognized that the total resources are not restricted to $1.2 million. Other resources for finance and services exist which may be tapped and these should be considered in the initial planning of the Project.

Existing sources of baseline data currently being gathered and any data gathering methodology should be explored for possible use by ASEP.

A general outline of evaluation needs should be publicized for informative purposes and for critical constructive comment. External evaluation of the Project should be encouraged, and linked where possible with the interests/needs of the Project.

Some of the evaluation instruments and procedures the Project will require do not exist at present. These should be produced as a result of Project activities and part of this will need to be done outside the Project.

The service aspects of the Project are seen as having both a short-term and a long-term function.

The short-term service function should be seen as an intrinsic part of the development of the Project. The long-term function, for example, the setting up of more permanent resource centres, should be kept in mind by the Project.

We endorse the present guidelines for trialling Project material and the principle of localized trials in various parts of Australia.

We suggest that the function of trialling is greater than to provide feedback on materials as it involves aspects such as teacher education and State involvement.

Best Avialable